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TRANSFORMATIONS OF PLANORBIS AT STEINHEIM, WITH REMARKS ON THE EFFECTS OF GRAVITY UPON THE FORMS OF SHELLS AND ANIMALS.[1]

BY ALPHEUS HYATT.

IN continuation of our review in this journal for October last (p. 793) of Professor Hyatt's contribution to the evolution theory, we make the following extracts from his last condensed paper, and reproduce from the Proceedings of the American Association the plates illustrating the paper. The results of his studies on the Steinheim shells are roughly exhibited on Plate VI, and may be described briefly as follows. Figs. 1, 8, 12 and 16, are the ancestors, varieties of *Planorbis levis* from the older Tertiaries of another locality, identified, named, and kindly sent to me with eleven other specimens of this species by Professor G. Sandberger,[2] who opposes the evolutionary conclusions of both Hilgendorf and myself.

From these four varieties spring four distinct lines of descent. Fig. 1 begins the series from 2–7, in which of course numbers of the connecting forms are not figured. Fig. 8 begins the series from 9–11, much shorter and containing fewer forms than in series 2–7. Fig. 12 also gives rise to a short series with only few forms. Fig. 16, however, is the starting point for a compound series, or one composed of at least three sub-series, 19–20, 21–24, and 25–28.

The intermediate forms by which the gap between the four

[1] From the Proceedings of the American Association for the Advancement of Science, Vol. XXIX, Boston Meeting, August, 1880.

[2] The author of the most complete Memoir on Tertiary shells in existence, Conchylien d. Vorwelt.

ancestors and the four first forms of each series, viz: 2 and 9 and 17, which occur in the Steinheim basin, is very complete, but neccessarily left out in this plate.

Numbering the series from right to left we see that Series I has three sub-series. Two of these show a tendency to uncoil, to become distorted and smaller than the ancestor, Fig. 16, while the third decreases in size, but has a form, Fig. 20, which is turreted like Figs. 11 and 6.

Series II maintains a size about the same throughout, but becomes flatter than the originating form, Fig. 12. Series III grows sensibly larger, and 10–11 are turreted-shells with a more rigid and sub-angular form of whorl than the primal form of Fig. 8.

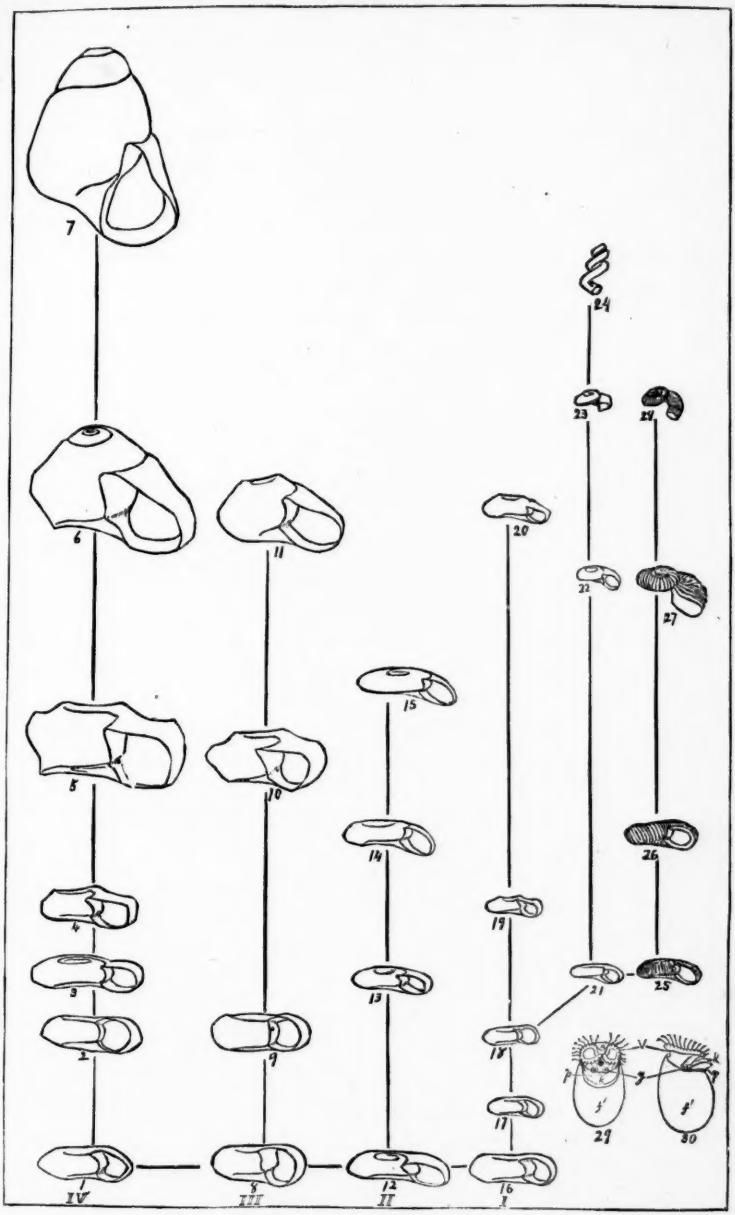
Series IV exhibits not only greater increase in size, but vastly greater differences in form and in other characteristics of the shell from Fig, 1, with which it started.

We can, therefore, without fear of error call series IV a highly progressive series; Series II a persistent series; sub-series 3 of Series I a partly retrogressive series; sub-series 2 of Series I, a purely retrogressive, and sub-series 1 of Series I also partly retrogressive; since, though it decreases in size and becomes deformed and uncoiled, it also has a tendency to produce a new characteristic, the transverse ribs, and also increases in size its more closely coiled forms, as in Fig. 26.

There is also other testimony going to show that this classification is correct. Semper's researches on *Lymnæus stagnalis* show, that under the most favorable physical conditions, this species increases to a maximum of size and has larger whorls, while under less favorable conditions with relation to food and temperature, the size is very much decreased.

The immediate results of weakness, produced by wounds, are also important in this connection. Pl. VII, Figs. 21, 21*a* and 22, a diseased *Pl. oxystomus*, var. *revertens* Hilg, is a diseased specimen of the same species as Fig. 9, Pl. VI. Compare this diseased, partly uncoiled, shell with the species, Fig 23, Pl. VI, *Pl. denudatus* and *minutus*. The weakness consequent upon old age is equally significant and has a similar meaning. Pl. VII, Fig. 22, represents the effect of old age in distorting the growth of the outer whorl of *Pl. oxystomus*. Compare with Fig. 22, Pl. VI. These are true cases of disease of comparatively rare occurrence in *Pl. oxystomus*. I have in my collection many similar

PLATE VI.



TRANSFORMATIONS OF PLANORBIS AT STEINHEIM.

cases and have lately found some diseased shells of *Pl. trochiformis*, Fig. 7, Pl. VI. These are dwarfed, and show a tendency to unwind the spiral ; so that they look remotely like the beginning of a series of transition forms from *Pl. trochiformis* to *Pl. denudatus*, Fig. 24, Pl. VI.

The following extracts contain the author's conclusions on the influence of the environment on mollusks:

Darwinists would say that want of bilateral symmetry or the unsymmetrical spire was of advantage to the animal, therefore it was selected and perpetuated.

Now this statement may be readily accepted, with the understanding that the "therefore" does not imply a relation of causation.

Most of the characteristics caused by the physical surroundings are of course advantageous, but the physical forces are the causes and not the advantageous or disadvantageous nature of the characteristic.

The form of the embryonal shell is straight, bag like or swollen, tubular; Figs. 29–30, Pl. VI.

The simplest form of all is a disk with which this embryonal bag begins, but this or the embryonal shell is not necessary for us to consider.

The coiled unsymmetrical shell (*ba*) is carried above the foot (*k*) as in the *Helix pomatia*, Fig. 8, Pl. VII, and Planorbis, Fig. 8 *a* Pl. VII. This is built by the mantle or internal soft covering of the body *d*, Fig. 9. The shell has been removed, and the fleshy cone of the mantle containing the stomach, intestines, etc., has been partly unrolled to show that it was originally coiled up inside the shell. The structure of the shell can be more easily understood in forms like Figs. 11, 12, Pl. VII, where the mantle is not so long and not coiled, but builds a broad, evenly balanced, conical roof above the foot as in the Patella or Limpet. If this shell be divided into halves and one half removed as in Fig. 12, the structure of the shell becomes visible and also the relations of the mantle *d*, and the mantle border *d'*, to each other and to the two layers of the shell, *e*, and *e'*.

This animal was once small enough to occupy only the upper part of this cone and then as it grew in size built the shell above itself. The outer layers, *e*, Fig. 12, the outer edges of which are seen also on the surface of the shell, *ba*, Fig. 11, were plastered up, one inside of the other, by the mantle border, *d*+, which exactly fits

the last one formed, and the inner, longer layers e' which simply serve to strengthen and support these are laid on by the mantle itself, *d*, Fig. 12.

The mantle border in the gasteropod forms a sort of collar, *d*+ Figs. 8 and 12, Pl. VII, around the edge of the mantle, through which the creeping disk or foot projects when the animal is expanded. The mantle border among the lamellibranchs *d*+Fig. 18, Pl. VII,[1] forms a wider opening, or slit fore and aft, but it serves the same purpose of an aperture for the protrusion of the foot, when this is used as an external organ of motion, Fig. 18, Pl. VII.

Any force which, would confine or interfere with the excreting surfaces of the mantle border, would affect the form of the imbricated layers e' which determine the shape of the shell, and thus change or curve the form of the cone. The weight of the shell itself or gravitation is such a force. If we try to account for the regularity of the spirals, whether bilateral or unsymmetrical, we are struck by the fact of their great regularity of curvature, and that this regularity can only be accounted for as the result of some general and constantly acting physical force, which tends to make the bag-like, straight shell of the young bend first into a bilateral spiral and then into an unsymmetrical spiral.

The force of gravitation, unless counteracted by great muscular strength, or the equilibrium of a perfectly cone-shaped, erect shell, as in some mollusks, would make the growing shell hang back and weigh upon the hinder portion of the border of the mantle, thus compressing the excreting surface in that quarter and decreasing the breadth of the shell layers built by this part.

This would make the shell assume the form of a bent cone or the bilateral spiral as in Figs. 24–25, Pl. VII.

The unsymmetrical spiral would be occasioned by any additional inequality in the weight of one side over the other, which could be occasioned by the distribution of the heavier internal organs, particularly of the stomach, ovaries, etc. Any irregularities of weight on one side more than the other would, it is obvious, also compress that side as well as the back part of the mantle border, and tend to narrow the deposits.

This would occasion a deflection laterally, and we should have what is so commonly the case, a shell bilateral in the young or at the apex becoming by growth unsymmetrical or spiral.

[1] See also Fig. 3, a fresh water clam (Anodonta) thrown widely open.

This explanation is obviously applicable to the regular spirals, but the test cases are the irregular spirals.

These occur through weakness occasioned by wounds, disease, Fig. 21, Pl. VII, or old age, as in Fig. 22, Pl. VII.

All of the distortions thus produced tend to be irregular, that is the animal becomes too weak to counteract the effects of the weight of the shell by its inherited muscular power, and it falls over more or less to one side destroying the regular curve of the spiral. This falling over to the side of greatest weight occasions an irregularity in the deposition of the outer shell layers, and the shell becomes more and more irregular as the animal grows weaker in old age or through disease.

Another proof of the effects of gravity lies in the fact, that the irregularity of form of the shell is proportional to the extent to which it is supported and the excreting border of the mantle relieved from the effects of its weight.

Thus, a perfectly regular spire in the young, by being supported, is turned into an irregular meandering tube in the after growth of the same animal.

Magilus antiquus crawls freely when young among corals, and has, during this period, a regular turreted shell, Fig. 23 *ba*, Pl. VII. It becomes finally fixed in the growing coral, which completely invests and supports it, and thereafter its shell is a rough irregular tube growing upwards in the direction of least resistance. The border of the mantle being free from compression on all sides, deposits shell matter about equally all around in the specimen figured, and therefore grows upward in a straight line.

The Vermetidæ are supported in various degrees in the adults but free in the young. Their shells, therefore, though having a regular spiral in the young, are in proportion to the support received, transformed into tubes more or less meandering after they become attached as in Fig. 10 *a*, Pl. VII, or loose irregular spirals rising up like corkscrews and only supported on one side as in Fig. 10.

The Ammonoids and Nautiloids are notable for the complete bilateral symmetry of their spiral shells.

Diseased specimens, which are not infrequent, however, tend to become unsymmetrical, coiling like the Gasteropods, as is well known to all experienced palæontologists. These are commonly spoken of by Quenstedt and others as diseased or deformed or sick species.

Once at the Sorbonne in Paris, Professor Hèbert, a distinguished French palæontologist, showed me a magnificent series of uncoiled Cretaceous Ammonites, and by way of testing these conclusions, I asked this question:

"Where, M. Hèbert, is the closely coiled symmetrical form which ought to be found with these?" He turned to the other side of the room, and pointed out the required form, saying, "There it is, I found it last summer."

These and other facts of a similar kind indicate that when physical surroundings become unfavorable to any organization, it takes on a certain series of retrograde transformations.

When they occur in the individual in the decline of life, or prematurely in the course of growth, through disease, they are similar to the characteristics of whole species, and even groups of degenerate forms. As in the case described above, Fig. 22, Pl. VII, is taken from an aged specimen, but it is distorted in the same way as the diseased specimen, Fig. 21, Pl. VII, and the retrogressive or degraded species of Series I, Pl. VI.

All the facts corroborating this assertion have already been published and are too numerous to be described in the limits of a paper like this.

The direction of the spiral is backwards or away from the mouth in the Gasteropods and towards the mouth in the Lamellibranchs; in, both, however, it is in the direction in which gravitation acts with greatest effect.

The Lamellibranchs have a split shell, with two valves. Each valve is unsymmetrically spiral, but there is one on each side of the vertical axis or *axis of gravity*, so that they balance each other and together form a bilaterally symmetrical shell, Figs. 15, 18, seen from the side, and 16, 17, from behind; *a*, spiral of right valve, and *b*, spiral of left valve.

The spiral and the outlines of the valves are equal on either side except in those forms which change the vertical axis and lie habitually on one side.

These are deformed and unequal; the deformation is in accordance with the amount of support and the resistance of the surroundings.

Thus oysters may grow to the right or left or very irregularly, fitting the curvature of surface, Fig. 13, Pl. VII. In the young they

are free moving, bilaterally symmetrical, and for a time attached by a byssus, and then lie over on one side.

Their symmetry is precisely accordant with these changes ending with having the lower valve permanently attached and larger and more concave than the upper.

Fig. 14, Pl. VII, shows the outlines of a clam shell above that of an oyster shell, and both in their real positions for comparison with each other, the beaks of the clam shell being upon the back and those of the oyster shell across the anterior or mouth end of the animal which has built the shell. The positions of the mouth in each animal are shown at *l*, *l*.

Fig. 18, Pl. VII, shows one side of a clam supposed to be buried in the mud with the siphons extended to the surface and the mantle border or shell-building organ *d* +, and the digging foot *k*, in their natural expanded condition.

What are the changes which can take place in a member of the oyster family by change of habit?[1] Can an animal of this family, which is always unsymmetrical when lying on one side, have a different position and thus return to the normal condition and have valves which are symmetrical and bilateral?

This question is answered by Lima, one of the same group as the oyster, a free swimmer but also burrowing into sponges as the clam does into the earth. This change of habit produces a corresponding change in symmetry, and it becomes like the clam, also perfectly bilateral, Fig. 16, Pl. VII.

On the other hand, can one of the fresh-water clams, Fig. 3, 17, Pl. VII, which are the reverse of the Ostreadæ, being almost invariably free moving or burrowing, and habitually bilateral, become attached, and if so does its shell become distorted like that of an oyster?

The answer to this is Mulleria and genus Ægeria. Mulleria, Fig. 19, becomes attached and is distorted so as to resemble the oyster and not only that, but the animal changes, since there is but one large muscle *g*, as in the oyster, Fig. 1, Pl. VII, in place of

[1] The effects of change of habit have lately been followed out by Dr. Anton Dohrn in an essay in which he shows the results of change of function induced by new conditions to be the transformations of the organs themselves. His hypothesis states that new habits bring about or induce the organs to exercise apparently new functions, which were latent or only partly developed under the original conditions of the surroundings. See Der Ursprung und d. Princip des Functionswechsel, by Dr. Anton Dohrn, Leipzig, 1875.

the two muscles used to close the shell in the clams, *g*, *g*, Fig. 18, Pl. VII, and the beaks of the shell have shifted from the middle of the back to the anterior end. Probably all attached animals show this tendency. Their attached and supported parts, the bases of the stems, etc., are irregular in form and growth, and their free upper parts more or less laterally symmetrical. The radiate symmetry of the soft bodies of corals and of the harder, plate-covered cups of the Crinoids, the attached parts of the Ascidians as compared with their freer bodies above; the perfect bilateral symmetry of the free moving parts of the Mollusca, as in the Helix, Fig. 8, Pl. VII, and Planorbis, Fig. 8 *a*, as compared with their supported spiral shells, the same perfection in the free Eolis, Fig. 2, Pl. VII, which has no shell in the adult, and in most of the Pteropods, Fig. 7, Pl. VII, free swimming animals, as well as in the Cephalopods, Fig. 5, Pl. VII.

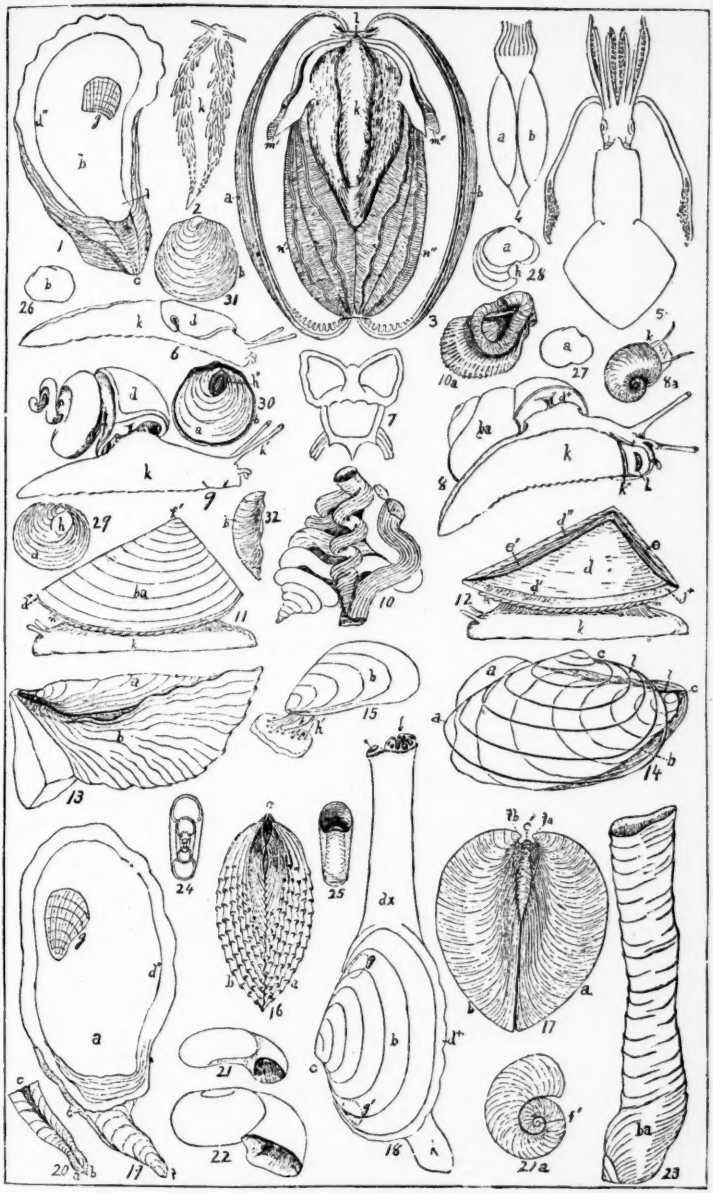
One of the best proofs of this position lies where it is least to be expected. The Brachiopoda are attached by a peduncle, or fleshy stem, and the upper valve, and not the lower, is the larger, just the reverse of the oyster.

Upon examination, however, it is found that it is the upper valve which is held by the peduncle and the lower valve alone opens and closes. Then again Lingula, another type of Brachiopod, which is not fixed by its peduncle, but simply occupies a sand burrow, and can move its valves sidewise, one over the other, has equal valves. Professor E. S. Morse's investigations have shown that the symmetry in these animals changes from a worm-like upright form of three rings or segments, and becomes laterally symmetrical by subsequent changes in the form of the first and second segments, the third changing into the peduncle. Here then a round worm-like form exchanges its cylindrical shape for a flatter, shell-covered body in two of its segments, which become bent over into a horizontal position, while the third, which remains vertical, retains the original round tubular form.

The Anomia, Figs. 31, 32, Pl. VII, presents a series of changes very similar in their meaning, though this animal is closely allied to the oyster.

It has the lower valve flat, resting upon and taking the form of the surface upon which it grows. The upper valve, *b*, Figs. 30–31, is convex and larger than the lower concave valve, *a*, Fig. 30, and is supported by a plug, *h''*, passing through the lower valve.

PLATE VII.



EXAMPLES OF EFFECTS OF PHYSICAL SURROUNDINGS ON MOLLUSKS.

In this case in which also the upper valve is the larger, it is this which receives the direct support of the attached plug.

The young are at first free, then attached by a byssus. Figs. 26, 27, show the right and left valves at an age when the animal has fallen over on the right side, and the notch, Fig. 27, begins to be formed.

Fig. 28 shows how the lower valve continues to build out around the notch towards the anterior end, and in Figs. 29 and 30, it becomes complete. This greater demand upon functional activity of the lower side of the mantle, and the fact that this is the movable valve, explains why it is not larger than the upper valve as in the oyster.

As was pointed out to me by Mr. J. S. Kingsley, the growth of the upper and lower valves sidewise is really an effort on the part of the animal to recover, by lateral growth in a new direction, the symmetry lost when it fell over on its side. Any one comparing Figs. 28 and 31–30 will see that the long axis of the form in Fig. 31 is at right angles to what it is in Fig. 27.

I shall call this tendency, to equalize the form in the direction of a horizontal plane, *geomalic;* the downward tendency of the growth being designated by botanists, *geotropic.*

The Anomia, when it falls over, loses its bilateral symmetry, because the right and left sides become upper and lower, and being in the vertical position, they are unequally affected by gravity and by change of function. At the same time the dorsal and ventral sides, which were before vertical, have become horizontal; and the geomalic growth of the ventral side, in order to restore the lost equilibrium in a horizontal direction, at once begins. This does not attain perfect lateral symmetry. The form of the animal cannot be easily changed, and the dorsal and ventral sides are still distinguishable; therefore, it is necessary to call this tendency of the growth by a new name, so that we can speak of the dorsal and ventral as well as the right and left sides as having the same tendency to assume by geomalic growth the natural and inevitable condition of equilibrium. The experienced observer will at once think of many apparent violations of this law.

Many larval forms of Gasteropods begin to build the spiral, while they are still within the egg, or still free swimming animals.

Balfour[1] states, in his masterly summary of Comparative Embry-

[1] Comparative Embryology, vol. 1, p. 190.

ology that, during an early larval period, "in most Gasteropods, the shell and mantle extend much more to the left than towards the right side and that the commencement of the spiral shell is thus produced." This same explanation applies to the falling over on one side of the young Anomia and oyster, in so far as the side upon which they fall is heavier than the other or upper side.

These seem to be readily accounted for as the direct results of hereditary peculiarities which have arisen in their ancestors and become embryonic through the action of the law of quicker development or acceleration explained above, and into the same category comes also the straight anomalous bag-like shell or plate of the embryo, and the split bivalve shell of the young oyster, which according to Professor Brooks is never an embryonic plate as in other Lamellibranchs.

The problem has not been approached among animals as it has among the plants by Sachs, Darwin and others. and we do not know how to distinguish between the direct effects of gravitation upon the growth of any animal at any one stated period of its life, and the effects of the proximate causes arising from the inherent tendencies of heredity.

Notwithstanding these imperfections in the evidence, and the absence of experimental proof, it has appeared to me that the discussion of this question would not be without usefulness in calling attention to what seems to me one of the most fruitful lines for experimental research. This, though now attracting much interest among botanists, on account of Sachs' experiments and Darwin's last book, is neglected by zoölogists.

In conclusion, Hyatt summarizes what he has endeavored to condense in his brief communication.

I have tried to show the results of the study of the history of a single species, *Planorbis levis*, and its evolution into many distinguishable forms, of which 14–19 may with justice be called by different names and considered as distinct species. I have also striven to bring into comprehensible shape the following conceptions:

First, that the unsymmetrical spiral forms of the shells of these, and of all the mollusca, probably resulted from the modification of the action of the laws of heredity, produced by gravitation.

Second, that there are many characteristics in these and in other groups of shells which are due solely to the uniform action of the

physical influence of the immediate surroundings, varying with every change of locality, but constant and uniform within each locality.

Third, that the Darwinian law of natural selection does not explain these relations, but applies only to the first stages in the establishment of the differences between forms or species in the same locality. That its office is to fix these in the organization and bring them within the reach of the laws of heredity.

Fourth, that after this is done, they are inherited according to the law of heredity with acceleration, which shows us in what manner these differences and all other inheritable characters, however originated, may with greater or less rapidity, become incorporated in the young of descendant forms and species.

Fifth,[1] that in these earlier stages they are more or less protected from change and may therefore remain comparatively invariable through long periods of time, or may be exposed to great changes in exceptional cases, and modified accordingly.

Sixth, that these phenomena show, that in growth, reproduction and heredity by acceleration, there is manifested a decided reaction of the organism, which succeeds in building up and maintaining the type structure and form, under all ordinary or normal terrestrial conditions, but in some cases fails in fully accomplishing this when exposed to exceptional surroundings, as in some cases of parasitism.

Seventh, that gravity appears to be one of the causes of the differences in effort, function and anatomy observed between the sides or ends of animal forms when in vertical relations to each other and to the earth, whether these be the anterior and posterior ends of the form, or the dorsal and ventral, or the left and right sides.

Eighth, that the bilateral or geomalic growth observed in the internal organs and the external parts of the organism when their sides are in their original and hereditary positions, and the geomalic growth of the dorsal and ventral sides, when these become horizontal through change of habit, appear to be directly or indirectly, responses to the demands of gravity.

Ninth, the origin of the limbs, etc., in pairs, while mere buds,

[1] The fifth and sixth propositions are not discussed in this communication for want of space, but were given in the Memoir on Steinheim Shells above quoted, and in the evening lecture of which this is an abstract.

is difficult to account for, if they are not considered as the results of the efforts of the tissues of animals to maintain the equipoise of all the parts by geomalic growth in obedience to the laws of gravity.

EXPLANATION OF LETTERS.

a, right valve; *b*, left valve; *ba*, shell; *c*, hinge area; *c'*, hinge ligament; *d*, mantle; *d'* + mantle border; *d''*, inner limit of mantle border; *d'''*, pallial line or trace made by *d'* on the inner side of the valves; *dx*, siphon of double funnel of clam; *e*, outer layers of shell built by the mantle border; *e'*, inner layers of shell built by the mantle itself; *f*, beaks of young valves, still remaining to form the beaks of the two valves; *fa*, right beak; *fb*, left beak; *f'*, beak, apex or young shell of Gasteropod still remaining at the center of the spire in Gasteropods; *g*, impression or mark made by the posterior adductor muscle on the interior of the valves; *g'*, position of anterior adductor muscle shown through the shell only by a dotted line; *h*, depression or hole made by the byssus or byssal plug in the lower valve of Anomia; *h'*, byssus of threads; *h''*, byssal plug; *k*, foot or crawling disk; *k'*, tentacles or feelers; *k''*, division between foot and head; *l*, position of the mouth; *m*, palpi, or flaps for conveying the food into the mouth; *m'*, right pair; *m''*, left pair; *n*, gills; *n'*, right pair; *n''*, left pair.

PLATE VI.

The specimens from Undorf all belong to an older Tertiary period than that at Steinheim. Plate VI is copied from Pl. 9 of memoir above quoted, except Figs. 29–30.

SERIES IV.

FIG. 1, Pl. levis, Undorf.
" 2, " Steinheimensis, Steinheim.
" 3, " tenuis, / Steinheimensis, } [1] "
" 4, " tenuis, "
" 5, " discoideus "
" 6, " trochiformis, / discoideus, } "
" 7, " trochiformis, "

SERIES III.

" 8, " levis, Undorf.
" 9, " oxystomus, Steinheim.
" 10, " supremus, "
" 11, " " var. turrita, "

SERIES II.

" 12, " levis, Undorf.
" 13, " crescens, / parvus, } Steinheim.
" 14, " crescens, "
" 15, " " "

SERIES I.

Sub-series 3.

" 16, Pl. levis, Undorf.
" 17, " minutus, / levis, } Steinheim.
" 18, " minutus, "
" 19, " triquetrus, "
" 20, " " "

Sub-series 2.

" 21, " minutus, Steinheim.
" 22, " denudatus, / minutus, } "
" 23, " denudatus, / minutus, } "
" 24, " denudatus, / var. distortus, } "

[1] Names written in this way indicate the transition forms, as in this case the variety connecting Steinheimensis with *tenuis*.

Sub-series 1.

FIG. 25, " $\frac{\text{costatus.}}{\text{minutus,}}$ } Steinheim.

" 26, " costatus, "

" 27, " costatus, var— "

" 28, " costatus, var— "

" 29, Doto coronata? young showing the oval shell and the swimming organ or velum from above. *V*, velum, *y*, eyes, *f*, operculum, the hinged disk used in closing the opening of the shell when the velum and foot, *k*, are drawn into it as the animal retracts. The mouth is indicated by the black spot near the center of the velum.

" 30, View of the same taken partly from the side.

PLATE VII.

FIG. 1, Left or lower valve of oyster (Fig. 13 *b*).

" 2, Eolis seen from above (after Adams).

" 3, Anodonta with shell open.

" 4, Young of oyster (after Brooks), abdominal view.

" 5, Loligo pallida (after Verrill), dorsal view.

" 6, Limax, side view.

" 7, Cavolina, dorsal view (after Brown).

" 8, Helix, seen partly from the under side.

" 9, The same with the shell dissolved by acid, showing the conical bag of the mantle partly unwound.

" 10, Vermetus tricarinatus, group of.

" 10*a*, " a broken specimen winding about on a shell of Lima.

" 11, Patella, diagram showing relation of shell to the crawling disk.

" 12, Same, edge of shell in section, and mantle exposed on one side.

" 13, Oyster in natural position attached firmly to a stone, but projecting without other support for about ¾ of its own length.

" 14, Clam shell (Mya) in outline above an oyster shell and both in the same position with reference to the structure of the two animals, if these were in their places inside of the shell.

" 15, Mytilus edulis (after Morse), common mussel attached to a stone by its byssus with the foot protruded.

" 16, Lima, view from the posterior end, showing bilateral symmetry.

" 17, Anodonta, same.

" 18, Mya arenaria. Common clam seen from the side with the siphon and mantle-rim or foot extended.

" 19, Mulleria, right or attached valve, with the solidified beak and the young shell showing at the end of the beak (after Adams).

" 20, Beak of the same showing the form of the young shells, from the dorsal side.

" 21, Pl. oxystomus, var. revertens, spiral showing the unwinding in an adult individual, due to disease.

" 21*a*. Top view of Fig. 21, and showing also the nucleus or young shell.

" 22, Pl. oxystomus, extremely old specimen showing similar unwinding of the spiral due to the weakness of senility.

" 23, Magilus antiquus, showing the regular spiral below and the irregular straight shell above built after the spiral shell has been buried in the coral (after Woodward).

" 24, Pl. steinheimensis, var. æquiumbilicatus, view of section showing how perfectly balanced the two sides of the spire are in some shells during their entire growth.

" 25, External view of the same shell, seen from the ventral side.

" 26, Anomia, young shell, left valve (after Morse).

" 27, Anomia, young shell, right valve (after Morse).

" 28, Anomia, young shell, right valve after the shell is turned so as to rest on this valve, which is now below and is making an effort to readjust the lateral symmetry by the geomalic growth of this valve around the byssal plug (after Morse).

" 29, The same, with the same valve after it has been built around the byssal plug (after Morse).

" 30, Anomia glabra, a full-grown shell, seen from the lower, right side, with upper left valve showing its projecting edges and beak beyond.

" 31, The same from the upper or left side, lower shell necessarily concealed.

" 32, The same from the anterior end to show distortion produced by the change in position. The lower or right valve is too concave to be visible.

[All figures not otherwise designated are original.]

ON ARCHÆSTHETISM.

BY E. D. COPE.

I. The Hypothesis of Use and Effort.

THE claims of the theory of Lamarck, that use modifies structure in the animal kingdom, are being more carefully considered than heretofore, and are being admitted in quarters where they have been hitherto neglected or ignored. Eleven years ago I restated the question as follows:[1]

"The influences and forces which have operated to produce the type structures of the animal kingdom have been plainly of two kinds: 1. *Originative*, 2. *Directive*. The prime importance of the former is obvious; that the latter is only secondary in the order of time or succession, is evident from the fact that it controls the preservation or destruction of the results or creations of the first.

"Wallace and Darwin have propounded as the cause of modification in descent their law of natural selection. This law has been epitomized by Spencer as the 'survival of the fittest.' This neat expression no doubt covers the case, but it leaves the origin of the fittest entirely untouched. Darwin assumes a 'tendency to variation' in nature, and it is plainly necessary to do this, in order that materials for the exercise of a selection should exist. Darwin and Wallace's law is, then, only restrictive, directive, conservative or destructive of something already created. I propose then to seek for the originative laws by which these subjects are furnished—in other words, for the causes of the origin of the fittest.

"It has seemed to the author so clear from the first as to require no demonstration, that natural selection includes no *actively* progressive principle whatever; that it must first wait for the development of variation, and then after securing the survival of the best, wait again for the best to project its own variations for selection. In the question as to whether the latter are any better or worse than the characters of the parent, natural selection in no wise concerns itself."

In seeking for the causes of the origin of variation, the following hypothesis was proposed:

"What are the influences locating growth force? The only efficient ones with which we are acquainted, are, first, physical and chemical causes; second, use; and I would add a third, viz: effort. I leave the first as not especially prominent in the economy of type growth among animals, and confine myself to the

[1] The Method of Creation, 1871, pp. 2 and 18. Walker Prize Essay. Proceeds. Amer. Philos. Soc., pp. 230–246.

two following. The effects of use are well known. We cannot use a muscle without increasing its bulk; we cannot long use the teeth in mastication without inducing a renewed deposit of dentine within the pulp-cavity to meet the encroachments of attrition. The hands of the laborer are always larger than those of men of other pursuits. Pathology furnishes us with a host of hypertrophies, exostoses, etc., produced by excessive use, or necessity for increased means of performing excessive work. The tendency, then, induced by use in the parent, is to add segments or cells to the organ used. Use thus determines the locality of new repetitions of parts already existing, and determines an increase of growth force at the same time, by the increase of food always accompanying increase of work done, in every animal.

"But supposing there be no part or organ to use. Such must have been the condition of every animal prior to the appearance of an additional digit or limb or other useful element. It appears to me that the cause of the determination of growth force is not merely the irritation of the part or organ used by contact with the objects of its use. This would seem to be the remote cause of the deposit of dentine in the used tooth; in the thickening epidermis of the hand of the laborer; in the wandering of the lymph-cells to the scarified cornea of the frog in Cohnheim's experiment. You cannot rub the sclerotica of the eye without producing an expansion of the capillary arteries and corresponding increase in the amount of nutritive fluid. But the case may be different in the muscles and other organs (as the pigment cells of reptiles and fishes) which are under the control of the volition of the animal. Here, and in many other instances which might be cited, it cannot be asserted that the nutrition of use is not under the direct control of the will through the mediation of nerve force. Therefore I am disposed to believe that growth force may be, through the motive force of the animal, as readily determined to a locality where an executive organ does not exist, as to the first segment or cell of such an organ already commenced, and that therefore effort is, in the order of time, the first factor in acceleration."

A difficulty in the way of this hypothesis, is the frequently unyielding character of the structures of adult animals, and the difficulty of bringing sufficient pressure to bear on them without destroying life. But in fact the modifications must, in most instances take place during the period of growth. It is well known that the mental characteristics of the father are transmitted through the spermatozoöid, and that therefore the molecular movements which produce the mechanism of such mental characters, must exist in the spermatozoöid. But the material of the spermatozoöid is combined with that of the ovum, and the em-

bryo is composed of the united contents of both bodies. In a wonderful way the embryo develops into a being which resembles one or both parents in minute details. This result is evidently determined by the molecular and dynamic character of the original reproductive cells, which necessarily communicate their properties to the embryo, which is produced by their subdivision. Rud. Hering has identified this property of the original cells with the faculty of memory. This is a brilliant thought, and, under restriction, probably correct. The sensations of persons who have suffered amputation, shows that their sensorium retains a picture or map of the body so far as regards the location of all its sensitive regions. This simulacrum is invaded by consciousness whenever the proper stimulus is applied, and the locality of the stimulus fixed by it. This picture probably resides in many of the cells both sensory and motor, and it doubtless does so in the few cells of simple and low forms of life. The spermatozoöid is such a cell, and, how or why we know not, also contains such an arrangement of its contents, and contains and communicates such a type of force. It is probable that in the brain cell this is the condition of memory of locality. If now an intense and long-continued pressure of stimulus produces an unconscious picture of some organ of the body in the mind, there is reason to suppose that the energies communicated to the embryo by the spermatozoöid and ovum, will partake of the character of the memory thus created. The only reason why the oft-repeated stories of birth-marks are so often untrue, is because the effect of temporary impressions on the mother is not strong enough to counterbalance the molecular structure established by impressions oftener repeated throughout much longer periods of time.

The demonstration of the truth or falsity of this position so as to constitute it the true doctrine of evolution, could only be verified from the prosecution of the science of palæontology. It is only in this field that the consecutive series of structures can be obtained, which show the directions in which modification has taken place, and thus furnish evidence as to the causes of change. The most complete result of these investigations up to the present time, has been the obtaining of sufficiently full series of the Mammalia of the Tertiary period, to show their lines of descent. In this way the series of modifications of their teeth and feet has

been discovered, and the homologies of their parts been ascertained.[1] Perhaps the most important result of these investigations is the following: The variations from which natural selection has derived the persistent types of life, have not been general or even very extensive. They have been in a limited number of directions,[2] and the most of these have been towards the increase in perfection of some machine. They bear the impress of the presence of an adequate originating cause, directed to a special end. Some of the lines struck out have been apparently inadequate to cope with their environment, and have been discontinued. Others have been more successful and have remained, and attained further modification.

The reader can estimate the chance of the production of an especially adaptive mechanism in the absence of any pressure of force directing growth to that end. It appears to me that the probability of such variation appearing under such circumstances is very slight indeed, and its continuance through many geologic ages directed to the perfecting of one and the same machine, still smaller. For this reason, attempts have been made to demonstrate a mechanical cause for the modifications of structure observed. For these I refer to papers by Messrs. Alpheus Hyatt, J. A. Ryder and myself; by Professor Hyatt * * "Upon the effects of gravity on the forms of shells and animals;"[3] Mr. Ryder "On the mechanical genesis of Tooth Forms;"[4] and "On the laws of digital reduction;"[5] by myself "On the origin of the specialized teeth of the Carnivora;"[6] "On the origin of the foot structures of the Ungulates;"[7] "On the effect of Impacts and Strains on the Feet of Mammalia."[8] Now demonstration of the mechanical effects of the application of force to matter can only be obtained by observation of the process, and this cannot be seen, of course, by the observation of fossils. The

[1] Homologies and Origin of the Molar teeth of the Mammalia educabilia. Journal Academy Nat. Sciences, Philadelphia, March, 1874. Proceedings Academy Nat. Sci., 1865, p. 22.

[2] See Hyatt on this point, Tertiary Planorbis of Steinheim. Anniv. Mem. Bost. Soc. Nat. Hist., 1880, p. 20.

[3] Proceeds. Amer. Assoc. Adv. Science, 1880, p. 527.

[4] Proceedings Academy Philadelphia, 1878, p. 45, 1879, 47.

[5] Loc. cit., 1877, October.

[6] AMERICAN NATURALIST, March, 1879, p. 171.

[7] Loc. cit., April, 1881, 269.

[8] Loc. cit., July, 1881, p. 542.

relation of the observed facts to the hypothesis is, however, shown by the above papers to be so precise that it only needs observation on the production of similar changes by similar causes in living types, to give us a demonstration by induction, which will satisfy most minds. That such facts have been observed among the lower animals is well known. The change of form of animals without hard parts, in adaptation to their environment, is an everyday occurrence.

That these views are now shared by many naturalists is becoming every day more evident. Professor E. Dubois Raymond[1] has recently delivered a lecture before the physicians of the German army, on exercise or use, in which he makes some important admissions. We give the following extract: "We should be, therefore, free to admit, with some appearance of reason, that the vigor of the muscles of wings and of digging feet; the thick epidermis of the palm of the hand and of the sole of the foot; the callosities of the tail and of the ischia of some monkeys; the processes of bones for the insertion of muscles; are the consequences of nutritive and formative excitation, transmitted by heredity." In this position Professor Raymond is in strict accord with the Lamarkian school of evolutionists. But Professor Raymond still clings to the obscurities of the Darwinians, though Darwin himself is not responsible for them, in the following sentences: "It is necessary to admit along with development by use, development by natural selection, and that for three reasons. First, there are innumerable adaptations—I cite only those known as mimetic coloration—which appear to be only explicable by natural selection, and not by use. Second, plants which are, in their way, as well adapted to their environment as animals, are of course incapable of activity. Thirdly, we need the doctrine of natural selection to explain the origin of the capacity for exercise itself. Unless we admit that which it is impossible to do from a scientific standpoint, that designed structures have a mechanical origin, it is necessary to conclude that in the struggle for existence the victory has been secured by those living beings who in exercising their natural functions have increased by chance ("par hasard") their capacity for these functions more than others, and that the beings thus favored have transmitted their fortunate gifts to be still further developed by their descendants."

[1] *Revue Scientifique*, Paris, Jan. 28, 1882.

To take up first the second and third of these propositions, Professor Raymond does not for the moment remember that movement (or use) is an attribute of all life in its simplest forms, and that the sessile types of life, both vegetable and animal, must, in view of the facts, be regarded as a condition of degeneration. It is scarcely to be doubted that the primordial types of vegetation were all free swimmers, and that their habit of building cellulose and starch, is responsible for their early-assumed stationary condition. Their protoplasm is still in motion in the limited confines of their walls of cellulose. The movements of primitive plants have doubtless modified their structure to the extent of their duration and scope, and probably laid slightly varied foundations on which automatic nutrition has built widely diverse results. We may attribute the *origin* of the forms of the vegetable kingdom to three kinds of motion which have acted in conjunction with the physical environment; first, their primordial free movements; second, the intracellular movements of protoplasm; third, the movements of insects, which have doubtless modified the structure of the floral organs. Of the forms thus produced, the fit have survived and the unfit have been lost, and that is what natural selection has had to do with it.

The *origin* of mimetic coloration, like many other things, is yet unknown. An orthodox Darwinian attributes it to "natural selection," which turns out, on analysis, to be "hasard." The *survival* of useful coloration is no doubt the result of natural selection. But this cannot be confounded with the question of origin. On this point the Darwinian is on the same footing as the old-time Creationist. The latter says God made the variations, and the Darwinian says that they came by chance. Between these positions science can perceive nothing to choose.

I have attempted to explain the relation which non-adaptive structures bear to the theory of use and effort, in the following language:[1]

"*The complementary diminution* of growth nutrition follows the excess of the same in a new locality or organ, of necessity, if the whole amount of which an animal is capable, be, as I believe [for the time being], fixed. In this way are explained the cases of retardation of character seen in most higher types. The discovery of truly complementary parts is a matter of nice observation and experiment. Perhaps the following cases may be correctly explained.

[1] Method of Creation, p. 23, 1871.

"A complementary loss of growth force may be seen in the absence of superior incisor teeth and digits in ruminating Mammalia, where excessive force is evidently expended in the development of horns, and complication of stomach and digestive organs. The excess devoted to the latter region may account for the lack of teeth at its anterior orifice, the mouth; otherwise, there appears to be no reason why the ruminating animals should not have the superior incisors as well developed as in the odd-toed (Perissodactyl) Ungulates, many of which graze and browse. The loss to the osseous system in the subtraction of digits may be made up in the development of horns and horn-cores, the horn sheath being perhaps the complement of the lost hoofs. It is not proposed to assert that similar parts or organs are necessarily and in all groups complementary to each other. The horse has the bones of the feet still further reduced than the ox, and is nevertheless without horns. The expenditure of the complementary growth force may be sought elsewhere in this animal. The lateral digits of the *Equidæ* are successively retarded in their growth, their reduction being marked in *Hippotherium*, the last of the three-toed horses; it is accompanied by an almost coincident acceleration in the growth nutrition of the middle toe, which thus appears to be complementary to them."

II. The Office of Consciousness.

If the law of modification of structure by use and effort be true, it is evident that consciousness or sensibility must play an important part in evolution. This is because movements of animals are plainly in part controlled by their conscious states. The question as to how many of the actions of animals are due to conscious states at once arises. It is well known that most of the more strictly vital functions are unconsciously performed. Not only these, but many acts which have to be learned, come to be performed in unconsciousness. Further, movements appropriate to needs which arise at the moment, and which are ordinarily termed voluntary, because they require the introduction of more or less of the rational faculty, are readily performed by vertebrated animals deprived of a brain, through the agency of the spinal cord alone.[1] The history of the origin of these movements must then be traced.

The movements of living beings generally possess the peculiarity of design, in which they differ from the movements of non-living bodies. That is, their actions have some definite reference to their well being or pleasure, or their preservation from injury

[1] Such expressions as "unconscious sensibility" and "unconscious will" are not used here, as being self-contradictory in terms and without meaning.

or pain, and are varied with circumstances as they arise. This is not the case with non-living bodies, which move regardless of their integrity or that of objects near them. This characteristic at once suggests that some element enters into them which is wanting to the movements of non-living masses. It has been suggested that the attraction of animals for their food and their repulsion from pain are derivatives from the attractions and repulsions of inorganic bodies, supposed to be the exhibitions of the force called chemism. But this supposition does not explain the wide difference between the two classes of acts. The adaptation to the environment seen in organic acts is unknown to the inorganic world, while the invariable character of the motions of inorganic force is greatly modified in beings possessed of life. Whether consciously performed or not, the acts of organic beings resemble those of conscious beings actuated by instincts of hunger, reproduction and defense.

An explanation of these facts seems to be offered by a well known phenomenon. We know that it is true of ourselves and of many other animals, that while all new movements have to be learned by repeated attempts, with each succeeding movement the act becomes easier, and that finally it can be performed without requiring any attention whatever. If continued, the movement becomes automatic, so that it may be, or is performed in a state of unconsciousness. In the words of Spencer, nervous currents move most readily along accustomed channels. Thus the "habits" of animals may be looked on as movements acquired in consciousness, and become automatic through frequent repetition. Not only this, but the organization thus produced in the parent is transmitted to the succeeding generation, so that the movements of the latter are automatically and often unconsciously performed. This view may be even extended to the purely vital functions with every probability of its being the true explanation of their origin and development. On a former occasion[1] I wrote:

"In accordance with this view, the automatic 'involuntary' movements of the heart, intestines, reproductive systems, etc., were organized in successive states of consciousness, which conferred rhythmic movements whose results varied with the machinery already existing and the material at hand for use. It is not inconceivable that circulation may have been established by the suffering produced by an overloaded stomach demanding dis-

[1] Consciousness in Evolution. *Penn Monthly*, August, 1875, p. 565.

tribution of its contents. The structure of the Cœlenterata offers the structural conditions of such a process. A want of propulsive power in a stomach or body sac occupied with its own functions, would lead to a painful clogging of the flow of its products, and the 'voluntary' contractility of the body or tube wall being thus stimulated, would at some point originate the pulsation necessary to relieve the tension. Thus might have originated the 'contractile vesicle' of some protozoa, or contractile tube of some higher animals; its ultimate product being the mammalian heart. So with reproduction. Perhaps an excess of assimilation in well-fed individuals of the first animals, led to the discovery that self-division constituted a relief from the oppression of too great bulk. With the increasing specialization of form, this process would become necessarily localized in the body, and growth would repeat such resulting structure in descent, as readily as any of the other structural peculiarities. No function bears the mark of conscious origin more than this one, as consciousness is still one of the conditions of its performance. While less completely "voluntary" than muscular action, it is more dependent on stimulus for its initial movements, and does not in these display the unconscious automatism characteristic of the muscular acts of many other functions."

It was not proposed in the preceding paragraph that the contractility of living protoplasm should be regarded as due to consciousness, but that the location in a particular place of a contractility already existing, might be due to that cause.

The preceding hypotheses bring us to a general theory of the evolution of organic structures or species. It is that they are the result of movements long continued and inherited, and that the character of these movements was originally determined by consciousness or sensibility. It remains then to consider the nature of consciousness.

It may be mentioned that it is here left open whether there be any form of force which may be especially designated as "vital." Many of the animal functions are known to be physical and chemical, and if there be any one which appears to be less explicable by reference to these forces than the others, it is that of nutrition. Probably in this instance force has been so metamorphosed through the influence of the originative or conscious force in evolution, that it is a distinct species in the category of forces. Assuming it to be such, I have given it the name of Bathmism (Method of Creation, 1871, p. 26). Perhaps the contractility generally regarded as an attribute of living protoplasm may be a mechanical phenomenon dependent of course on nutrition; or it

may be the exhibition of a force peculiar to living beings; and hence one of the "vital" group.

III. Archæsthetism.

The doctrine of evolution derives the organs of special sense from those of simple sensibility or touch. In other words, their history has been that of other organs; the complex have been derived from the general and simple. There are then generalized consciousness and specialized consciousness. A number of forms of consciousness multiplies its vividness, the one kind reinforcing the other by a slightly different appreciation of the same thing. In the case of persons deprived of the sense of touch, the sense of sight is not sufficient to convince them of their own existence, as a matter of intellectual reflection. When there is no nervous system we must suppose sensibility to be generally distributed throughout the protoplasmic substance of the animal. The localization of consciousness must depend on a localization of the kind and condition of protoplasm which sustains it; while in other parts of the body the protoplasm is modified in other directions and for other purposes. If this be true, the nervous tissue of the higher animals should retain the characters of the lowest simple organisms. In point of fact this is the case, the nucleated cell being the essentially active element in the functions of brain and nerve, and being more numerous in that tissue than in any other.

The remarkable evanescence of consciousness is one of its most marked characteristics. It is this peculiarity which has lead many thinkers to deny its existence in the lower animals, and to induce others to believe that it can have had but little place among the causes of evolution. Partly for the same reason many biologists attempt to derive it by metamorphosis from some form of force.

But the nature of consciousness is such that it cannot be derived from unconsciousness, any more than matter can be derived from no matter, or force from no force. The "unthinkable dogma of creation" (Haeckel) cannot be applied to consciousness more than to matter or force. It is a thing by itself, and with matter and force, forms a trio of primitive things which have to be accepted as ultimate facts. This is perfectly consistent with the position that consciousness is an attribute of matter, and neither more nor less difficult to comprehend than the fact that

force is an attribute of matter. This view is maintained in a fashion of his own by G. H. Lewes. Professor Raymond[1] says in support of the same position:

"'More temperate heads betrayed the weakness of their dialectics in that they could not grasp the difference between the view which I opposed, that consciousness can be explained upon a mechanical basis, and the view which I did not question, but supported with new arguments, that consciousness is bound to material antecedents.' This position has been maintained by various writers, among them Professor Allman[2] and the writer. But Professor Raymond has not found it to be acceptable to his nearest cotemporaries. He says, 'The opposition which has been offered to my assertion of the incomprehensibility of consciousness on a mechanical theory, shows how mistaken is the idea of the later philosophy, that that incomprehensibility is self-evident. It appears rather, that all philosophizing upon the mind must begin with the statement of this point.' In stating this point some years ago, we used the following language:[3] 'It will doubtless become possible to exhibit a parallel scale of relations between stimuli on the one hand and the degrees of consciousness on the other. Yet for all this it will be impossible to express self-knowledge in terms of force.' And again,[4] 'An unprejudiced scrutiny of the nature of consciousness, no matter how limited that scrutiny necessarily is, shows that it is qualitatively comparable to nothing else. * * From this standpoint it is looked upon as a state of matter which is coëternal with it, but not coëxtensive.'"

It is probable then that consciousness is a condition of matter in some peculiar state, and that wherever that condition of matter exists, consciousness will be found, and that the absence of that state implies the absence of consciousness. What is that state?

It would be a monstrous assumption to suppose that consciousness and life are confined to the planet on which we dwell. I presume that no one would be willing to maintain such an hypothesis. Yet it is obvious that if there be beings possessed of these attributes in the planets Mercury and Saturn, they cannot be composed of protoplasm, nor of any identical substance in the two. In the one planet protoplasm would be utterly disorganized and represented by its component gases; in the other it would be

[1] Address on the celebration of the Birthday of Leibnitz, *Pop. Science Monthly*, Feb., 1882.

[2] Address delivered before the British Association for the Advancement of Science.

[3] Consciousness in Evolution *Penn Monthly*, July, 1875.

[4] The Origin of the Will, *Penn Monthly*, 1877, p. 439.

a solid, suitable for the manufacture of sharp-edged tools.[1] But as it is probable that protoplasm is adapted for the phenomena of consciousness by a certain peculiarity of its constitution, it seems evident that other substances having a similar peculiarity may also be able to sustain it. I have elsewhere attempted to discover what this is, in the following language:[2]

"Nowhere does 'the doctrine of the unspecialized' receive greater warrant than in the constitution of protoplasm. Modern chemistry refers compound substances to four classes, each of which is characterized by a special formula of combination. These are called the hydrochloric acid type, the water gas type, the ammonia type and the marsh gas type. These series are defined by the volumetric relations of their component simple substances: thus in the first, a single volume unites with an equal volume of hydrogen; in the second, two volumes of hydrogen unite with a single volume of another element; in the third, three, and in the fourth, four volumes of hydrogen unite with the single volume of other elements. Hence the composition of these compounds is expressed by the following formulas—chlorine, oxygen, nitrogen and carbon being selected as typical of their respective classes: HCl, H_2O, H_3N and H_4C. Now it is an interesting fact that protoplasm is composed of definite proportions of four simple substances, each one representing one of the classes above named, or in other words, the capacity for proportional molecular combination which characterizes them. The formula $C_{24}N_8O\ H_{17}$ expresses the constitution of this remarkable substance. Now although the significance of these combining numbers is unknown, there is a conceivable connection between the characteristic peculiarities of protoplasm and the nature of the substances which compose it. It is probable that these, when in combination with each other, exert a mutually antagonistic control over each other's especial and powerful tendencies to form stable, and hence dead, compounds. It is therefore reasonable that the terms 'unspecialized' or 'undecided' should be applicable to the molecular condition of protoplasm, and in so far it is a suitable nidus for higher molecular organization, and a capacity for higher forms of force conversion than any other known substance. If also in inorganic types, as in the organic, the generalized have preceded the specialized in the order of evolution, we are directed to a primitive condition of matter which presented the essentially unspecialized condition of protoplasm, without some of its physical features. We are not necessarily bound to the hypothesis that protoplasm is the only substance capable of supporting consciousness, but to the opposite view, that the probabilities are in favor of other

[1] Fraser in AMERICAN NATURALIST, 1879, p. 420.

[2] Consciousness in Evolution, 1875, p. 573.

and unspecialized, but unknown forms of matter possessing this capacity."

The condition of living protoplasm was also referred to in the following language in a later publication :[1]

"The cause of the difference between conscious and unconscious force must be secondarily due to different conditions of matter as to its atomic constitution; consciousness being only possible, so far as we can ascertain, to matter which has not fallen into fixed and automatic relations of its atoms."

Protoplasm in the form of food is not conscious; and tissue formed of protoplasm is not conscious, excepting certain cells where the forming process is in action. Nor is consciousness present in all cells where nutrition is active. From the increased consumption of energy, and the increased expenditure of energy (heat, Lombard) which takes place during conscious processes, we may well believe that the decomposition of protoplasm is more considerable in such processes than in other forms of nervous activity. We can imagine simple nutrition to be a condition of the elements of this substance in which the chemical force is simultaneously combining and dissolving its combination, and that during the process there is a condition in which the chemism is for the time being unsatisfied, though present. The direction which this nutrition or metastasis takes, is due to the arrangement of the molecules already existing in the tissue, the new molecules taking the form of the old ones in replacement, so long as no extraneous force interferes. That they are rearranged under the influence of consciousness is apparent in the origin of variations of structure in accordance with the views of evolution already entertained. It is the arrangement of the molecules which constitutes the automatic machinery of nutrition as well as of other activities, so that consciousness necessarily only appears in that stage of nutrition while the matter is in a transition state, and unformed. Whether chemism must be regarded as suspended, or only unsatisfied, at this stage, can only be imagined. As non-satisfaction is probably the temporary condition in all nutrition it is not unlikely that suspension may be the condition of consciousness.

Perhaps the character of the components of protoplasm is such, that the movements of their atoms, *i. e.*, their chemism, mutually

[1] The Origin of the Will, *Penn Monthly*, June, 1877, p. 439.

interfere and destroy each other, as in the cases of the interference of the waves of light and sound.

The colloid form of protoplasm is especially favorable to internal movements which shall not destroy the integrity of the mass, perhaps more so than a gaseous state in a compound of similar constitution. It is, moreover, more favorable to the preservation of molarity than a gas could be, on account of the ease with which it adheres to solid substances, and transports and locates them as part of its external and internal supports. But it is not inconceivable that under other conditions of temperature, etc., the gaseous condition of matter might answer the same purpose. It must be borne in mind, however, that this is a subordinate question, and that the real characteristic of the "physical basis of life" is to be found rather in its generalized *dynamic* condition.

We must then believe that wherever this generalized condition exists, consciousness will be present. As soon as mechanical or chemical force appears in the molecules of the sustaining substance, consciousness disappears. The organism has taken the first step towards death, but is not dead, but is *anæsthetized.* Constant nutrition is essential to the performance of all life functions, including consciousness, and it is evident that this is necessary to the maintenance of the unspecialized condition in which the latter appears.

Is the appearance of sensibility on the development of its sustaining condition, evidence that the latter stands to the former in the relation of cause and effect? If the view of the preëxistence of consciousness be true, there is no more relation of cause and effect than in the case of the opening of a door which admits a wind. The force expended in opening the door is not converted into the energy exerted by the wind as it enters the room. It simply releases it, or admits it to a new field. It is, however, true, that consciousness having once entered, a larger conversion of force is necessary to its persistence than is expended during its absence. Like combustion, which is only communicable under suitable conditions, consciousness having once been transmitted to a new *æsthetophore*,[1] lives on it, and requires constant supplies of material for its sustenance.

The hypothesis of the primitive and creative function of consciousness may be called *Archæsthetism.*

[1] Æsthetophore, a substance which sustains consciousness.

IV. Panæsthetism.

It has been the custom of men from the dawn of thought to attempt to construct for themselves cosmogonies and theologies. Science is yet far from supplying the facts necessary to the construction of a true system of the universe, and philosophy can only stretch out a little further into the unknown by the use of necessary inference. In spite, however, of the insufficiency of the data, men still suggest new views or cling to old ones, and an occasional flight into this region of thought, at least brings the thinker into sympathy with the thoughts of his fellow-men.

The admission of the possibility of the existence of consciousness in other forms of matter than protoplasm, and in other planets than the Earth, lends countenance to a rational belief in the so-called "supernatural" (better called the supersensuous) so prevalent among men in irrational forms. The question naturally arises, is there any generalized form of matter distributed through the universe which could sustain consciousness? The presumption is that such a form of matter may well exist. Evolution or specialization has only worked up part of its raw material in the organic world. Wherever primitive conditions remain, there primitive organisms abound. *Protozoa* are yet numerous on land, and the *Protobathybius* inhabits the depths of the sea. Highly specialized forms of life are in fact numerically a minority of living beings. May not this be true also of inorganic beings? It is thought that various celestial bodies represent unfinished worlds. Is it not probable that the grand source of matter not yet specialized into the sixty odd substances known to us, may still sustain the primitive force not yet modified into its species, and that this combination of states may be the condition of persistent consciousness from which all lesser lights derive their brilliancy? There is much to warrant such a view in the observed facts of life, taken in connection with the general course of evolution. Moreover that some form of matter connects the interstellar spaces, is thought to be proven by the transmission of light in some cases, and light and heat in others. That such a form of matter pervades all spaces whatever, is the theory of some physicists. If it be so generalized as to be capable of sustaining consciousness, it becomes the source from which other substances derive it, so soon as they, through the energy of nu-

trition, which resists death, maintain the same primitive and unformed constitution capable of exhibiting it.

Of course there is no evidence in our own memory of the existence of our personality prior to our human experience. No one on awaking from unconsciousness remembers having been anywhere in particular during the interval. These facts may be harmonized with the theory here presented, on the supposition that memory is lost on a transfer of consciousness from one physical basis to another. The arguments in favor of a transfer of consciousness do not sustain the idea of a transfer of memory. Memory requires an arrangement of molecules or atoms which when finished no longer exhibits consciousness. With proper stimulus, when the proper kind of force conversion is set up in them, consciousness extends into them, and taking their form, produces reminiscence or conscious memory. The molecular arrangement would be probably lost on a transfer of consciousness to a new material basis. It might then be supposed that with every such transfer a new personality is established. Though the correct definition of personality includes memory as well as consciousness, when viewed as an objective concept, it may be questioned whether memory is necessary to the subjective belief in one's own personality. Those insane persons who believe that they have lost their personality, and think that they are some one else, nevertheless recognize the fact that what they now are has a continuity of existence with what they once were. The material limitations of consciousness are the authors of the kind of personality it presents. A limitation or an expansion of its range would not destroy the idea of personality, but would simply restrict or extend it. The possible confluence of many personalities would not destroy them, but each one would regard the others as additions to himself, and himself, therefore, as so much the greater being.

As a summary of the preceding conclusions, the following analysis of metaphysical systems may be given. It defines the place of the doctrine of archæsthetism, above proposed, as distinguished from the opposing view of metæsthetism, which is held by many monists:

I. Consciousness ("spirit") is independent of matter.....DUALISM.
II. Consciousness is an attribute of matter.....MONISM.
α. Consciousness is primitive and a cause of evolution.....*Archæsthetism.*
β. Consciousness is a product of the evolution of matter and force
Metæsthetism.

ORGANIC PHYSICS.

BY CHARLES MORRIS.

I. The Chemical Evolution of Life.

IN regard to the question of the origin and character of organic energy the whole course of modern science leads steadily to one conclusion. This is, to express it plainly, that the formation of the organic body is a chemical problem, and the source of life force a question in physics. There has been a severe battle fought against this tendency to reduce life to a chemical equation. The adherents of the doctrine of vital energy have entrenched themselves behind many successive lines of defence, and are still fighting, with the bitterness of despair, behind their last barrier, that of protoplasm. Yet science has gone steadily on, breaking down, one by one, the dividing walls between organic and inorganic nature. Chemical experiment has shown that many of the organic compounds can be reproduced directly from their elements, by processes identical with or parellel to those which nature employs. Others, not yet reproduced, have been analyzed, and the character and mode of union of their constituents shown. The whole vast array of the lower organic compounds has been brought fairly within the field of chemistry, and laid out in definite formulæ. In this respect there no longer exists any organic chemistry. It is simply the chemistry of carbon compounds.

In like manner physical science has taken hold of the forces of living bodies, and has arrived at a similar conclusion. These forces seem to closely accord in degree with the energy that should arise from the quantity of oxidized products yielded. Oxidation must set free energy. This energy must manifest itself as some mode of motion. And if the energy really manifested in the body closely agrees with that which must arise from the oxidation performed, there is nothing left, in this direction, for vitality to do. Chemistry is visibly at work here, too, and vitality is pushed out of the field of view.

Only one point yet exists upon which any question can be raised, and that is the synthesis of protoplasm, or rather of the molecules of which it is made up. There is no question about its analysis. This is admissibly chemical. Oxygen is constantly at work reducing it to its elements. But this oxidation does not suddenly break it asunder into elementary particles. On the con-

trary it takes it apart, piece by piece, as men take down the timbers of a house. Protoplasm has evidently a definite chemical structure, and if it can be taken down piecemeal it can be built up piecemeal. If susceptible to chemical analysis it must be susceptible to chemical synthesis.

Moreover, animal bodies have nothing to do with the production of protoplasm. It is produced in plants alone. Animals simply add new protoplasm derived from plants to their existing protoplasmic tissues. Thus if vitality is confined in its action to the formation of protoplasm, then vitality exists in plants alone, and animals are destitute of it. Or if animals possess vital force its action is confined to assimilation, the causing of one fragment of protoplasm to cohere to another.

Evidently chemistry has driven vitality into a very close corner, and left it a very weak leg to stand upon. And if we give vitality its correct name this leg grows weaker still. It is not chemical or physical energy. It is none of the forces at work in inorganic nature. Therefore it is something supernatural. Its adherents do not claim this. They do not boldly declare what they necessarily imply, that the formation and assimilation of protoplasm are miraculous processes, and that organic existence is only sustained by a continual miracle. But their premises admit of no other conclusion. Yet the duty of miracle in this direction is a very limited one. Chemistry has free possession of the whole field, with the exception of a single obscure corner, in which alone the miracle of vitality tremblingly holds out.

There is a crucial test to which this final question may be put. There is one fixed condition under which alone the activity of protoplasm can display itself. Oxygen must always be present. There is no life without oxygen. When this element is abnormally abundant life proceeds with abnormal rapidity. When it is deficient in quantity life becomes sluggish. When it is prevented from entering the organism life ceases to exist. Hence vitality is incapable of displaying itself except in the presence of oxygen, and the problem becomes the following: so much oxygen so much vitality. The one is measured in terms of the other.

No one can imagine that the mere presence of oxygen sets the wheels of vitality in motion. Oxygen is too vigorous a chemical agent to rest at ease in contact with the weakly cohering molecules of protoplasm. It cannot but seize upon some of their con-

stituents. That it constantly does so we are well aware, and its vigor in this respect is in close accordance with the vigor of vitality. So much life action is represented by so much chemical action. Chemical waste of the tissues accompanies every exercise of vitality. Yet if vitality be some super-physical process, some miraculous energy by which life is sustained and growth proceeds, why is oxygen so absolutely necessary to its performances? Why does chemical action necessarily accompany it? The more closely we look into the matter the more evident it becomes that there is no such energy in existence as a special vital force, and that chemical affinity is the only energy active in organic processes.

Oxygen is much more than the scavenger of the organic body. It is its quickener. It is the life-giver to which all vitality is due. Its mode of action is undoubtedly destructive. But in destroying old constructions it yields the energy through which alone reconstruction can be effected. It is eating into life with an insatiable appetite, yet in doing so it gives off energies which constantly create new life. In the vegetable world the energy of the solar rays supplies the force necessary to the first step in organic synthesis, but oxygen does all the rest. Two opposite energies are constantly at work—chemical analysis and chemical synthesis—and the former is absolutely necessary to every step of the latter. Oxygen is incessantly engaged in the plant, breaking down its molecules into simpler forms. But in doing so it yields energy which is exercised in the formation of new and more complex molecules. Every step of analysis is followed or accompanied by a step of synthesis. All the energy yielded by oxidation in the plant is thus employed, and step by step organic chemistry advances, until the proteid molecules of protoplasm are finally produced.

In animals the life process does not differ essentially from that of plants. Yet chemically animals begin where plants leave off. The highest chemical product of plants serves as the nutriment of animals. Their principle of action is the same. Every act of chemical synthesis in both is preceded, or accompanied, by an act of analysis. Every step of a portion of matter up stairs is based upon a step of some other portion of matter down stairs. But in animals the process begins near the top of the stairs. Only a few steps can be made upwards; many steps can be made downwards.

Hence the energy set free in analysis is only partly needed for new synthesis. Certain changes perhaps take place in the proteid molecules, but the essential work performed is the assimilation of new material, closely similar to the protoplasm of the tissues. For this labor only a tithe of the energy set free by oxidation is requisite, and the remainder is ready for any other employment to which the organism can devote it. If not otherwise employed it becomes temperature energy, but it is also used in two special methods, as nerve and as muscle energy, and organic development is little more than an increasing specialization of these two modes of energy.

If now we come to seek the method by which assimilation of protoplasm, and growth of structure, is achieved in the animal body, we shall find it not easy to discover. Albumen is such a highly complex substance, and its chemical composition and changes in constitution are so far beyond the present appliances of chemical science, that we can only proceed by the process of analogy, and seek the possible instead of being able to display the actual. We are apt to speak of protoplasm as if it were one undeviating substance. Yet we might as reasonably speak of the several varieties of starch, of sugar, of woody fiber, of gum, etc., as a single substance. They are only variations of one special form of chemical molecule, and that a comparatively simple one. The molecule of albumen is excessively more complex than that of starch, and is therefore capable of an immensely wider series of variations, without essential change of constitution. And the more complex a molecule becomes the less its internal variations affect its physical constitution. Two simple oxides may differ very widely in physical character. Two unlike sugars present very slight differences. Two diverse albumens may present no appreciable difference. For all we know to the contrary not only the proteid molecules of every special animal tissue may have special constitutions, but also those of every diverse species of animal, and, in a minor degree, of every separate individual.

When we speak of protoplasm it is far from certain that we are speaking of a homogeneous substance. A mass of protoplasm is made up of chemical molecules which, even if similar in general constitution, may differ in important particulars. If, indeed, we come down to the basic principle of chemical action, we find it to be a satisfaction of active affinities. This satisfaction may be com-

pleted in a single step and inactivity be immediately produced, or it may require several successive steps, and inactivity be only gradually produced. Molecules in which considerable activity yet exists we denominate as acids or bases, accordingly as they diverge to the negative or positive side in their electric relations. Molecules in which activity has ceased, or has become very slight, we know as salts. If all their affinities are satisfied they are neutral salts. If acid or basic affinities yet exist they are acid or basic salts.

But the inactivity of a neutral salt only refers to its further synthesis. It is still susceptible of analysis. Some of its elementary materials may be taken from it by the affinities of an active element. And this loss of material leaves the molecule again energetic. It has become once more an active radical, and is capable of regaining the materials it has lost, or of taking up new ones. Thus it may form a new molecule more complex than the original one.

These modes of action of inorganic chemism certainly apply to organic chemism, even in its highest stages. Every exercise of affinity satisfies some of the active chemical energy of the molecule, and thus reduces its energies. When these are all satisfied it becomes inactive. It is a neutral salt, incapable of further synthesis, yet still open to analysis. But if we look upon a molecule of protoplasm as an organic salt it is evident that it may have many more bonds of unsatisfied affinity than an inorganic salt. An acid or basic inorganic salt is neutralized after taking up one or two monad atoms. An analogous organic salt may perhaps be able to take up successively ten or twenty monad atoms, or compound radicals.

These considerations are not without their bearing upon the question of the growth of protoplasm. Did the proteid molecule act only by its own chemical energies, evidently its action could not long continue. Although it might begin with many unsatisfied bonds, every new exercise of affinity would decrease its possible action. When all its affinities were satisfied growth must cease, and the molecule become a neutral salt. But though synthesis could proceed no further, analysis might act to again energize the molecule, and the more complex its condition the more subject it must become to analytic action.

Such seems to be the mode of operation in protoplasmic growth.

In fact there could be no other if this growth be a chemical process, for synthesis is a self-checking method and cannot long continue unless its energy be restored by analysis. If a mass of protoplasm be made up of molecules of the same chemical constitution they may yet differ in degree of satisfaction of their affinities, and may be partly neutral, partly basic, and partly acid in their energies. Any exercise of these affinities tends to reduce them all to neutrality, and thus to restrict their chemical action. But they are constantly exposed to the assaults of oxygen, which, at every contact, robs them of some of their constituents, and thus restores their chemical activity. We must certainly deduce some such conclusion as this from the necessity of oxygen to all life energy, and the increase in oxidized waste with every increase in vital activity. Oxidation gives rise to this vital activity, which consists in the restoration of active chemical affinity to the oxidized molecules, and in the reproduction of protoplasmic tissues. Both results arise from one cause. Oxygen robs matter from the proteid molecules, and restores their lost chemical energy. They assimilate new material from the nutrient fluid; while animal motion and temperature arise from the excess of energy yielded by the oxidation.

This general survey of the process leads us to a more particular conception of its character. There is a peculiar polarity concerned in all chemical processes which is of essential importance here. A neutral salt is really a polar arrangement of the elements. Its molecule has its positive and negative poles, but the energy of each restrains and balances that of the other. If we call such a molecule an acid salt, this is equivalent to saying that its acid pole has an excess of energy over its basic. New basic material is drawn in, and the poles become equal in energy, so that all their affinities are exercised internally. But if the constituents of this molecule be separated, their opposite chemical polarities at once become active. The one becomes an energetic base, the other an energetic acid. If this separation proceeds further, a portion of the products of the second separation becomes still more powerfully basic or acid, while other portions may return towards neutrality. If, for illustration, we take a molecule of the powerful acid H_2SO_4 and cause it to combine with two molecules of the equally powerful base NaOH, we obtain the neutral salt Na_2SO_4, two molecules of water being ejected. A redivision

of this salt into its constituents yields the acid and base above named. The chemical poles, from being passive, have become active. A secondary division of the base gives us Na and OH, a powerful positive element, and a weak negative molecule. If finally OH be separated into its constituents, we obtain an atom of the active negative element, oxygen, and one of the weakly positive element, hydrogen. Analysis of the sulphuric acid molecule yields like results, one of which will be the neutral substance H_2O, or water.

It may here be asked what has all this to do with the chemical activity of protoplasm? It may possibly have much to do with it. If this activity be a chemical one it is certainly governed by the ruling principles and processes of chemistry. There is another chemical mode of action which may also have a bearing upon this question—that concerned in the chemism of the galvanic circuit. In this circuit, as ordinarily constructed, there is but a single chemical energy in active operation, the affinity of the positive metal for the negative element of the fluid. For instance, in an ordinary form of battery, the oxygen of water combines with the metal zinc, the molecules of water intercharge their atoms throughout the line of the circuit, and free hydrogen is given off at the surface of the other metal employed. But if this second metal could be replaced by a substance having an affinity for hydrogen, a more vigorous chemical action might take place, with the production of new molecules at each pole. Perhaps such a double action does occasionally take place in the local circuits produced in ordinary chemical action. In the case of such a double action much weaker affinities than those usually employed might suffice.

Yet any such galvanic chemism is necessarily temporary in its action. Its activity diminishes as the analysis of the molecules of the liquid is followed by the formation of new and more stable compounds. There is only one possible method in which we can conceive a constant reinvigoration of its activities, and that is through a continual restoration of its original conditions by reverse chemical action. Could some active atmospheric element, for instance, constantly penetrate the liquid, break down its new formed molecules, and reproduce the original ones, while carrying away the neutralizing constituents, the chemical action of the battery might indefinitely retain its original activity. Its lost en-

ergies would be constantly replaced by energy derived from exterior nature.

Such a continual reinvigoration takes place in organic chemism. The exercise of the affinities of the molecules of protoplasm must constantly tend to reduce their energy, and produce a neutral inactivity. But oxygen comes in, bringing with it the chemical energy of the exterior world. The new-formed, inactive molecules are partly oxidized, and perhaps regain their original condition. The chemical vigor of the circuit is restored, and its activity may thus be ceaseless, since it is continually re-energized by the forces of exterior nature.

As a final deduction from the principles of inorganic chemistry, may be mentioned the fact that the activity of a galvanic circuit in which the affinities of both the positive and the negative constituents of the molecules of the liquid are engaged, must depend upon the vigor of the opposite polarities of the circuit. If either the positive or the negative energy be neutralized the chemical activity must be checked, while if one or both of these polar energies be decreased the activity of the circuit must be similarly reduced.

These principles of inorganic chemism might have been considered in more detail, since there is reason to believe that they are the agencies concerned in the higher organic chemistry. For the sake of brevity they have been given in a very condensed form with little attempt at illustration. It remains to apply them to the phenomena of what is called life action, or the assimilation and growth of protoplasm.

In considering this question we have to deal with the units of organic beings. Not the cell, but the nucleus of the cell, which is undoubtedly the active agent in protoplasmic growth. The nucleus is itself an organized body, and appears to contain other materials than the proteid molecules to whose chemical activity the phenomena of organic life are due. It is also evidently a polar organization, its polarity being markedly displayed at the time of its division. The two nuclei into which the original one divides represents each a polar half of the original nucleus. Thus the probable balanced polarity of the primary cell nucleus becomes an unbalanced polarity in the new cells resulting from its division. We hope to show that this is a fact of essential importance.

The protoplasmic mass which constitutes the nucleus is an aggregation of highly complex chemical molecules similar, perhaps, in constitution, but which may differ considerably in the degree of satisfaction of their affinities. Some may be neutral, some acid, and some basic salts of the same chemical compound. If such be the case we can comprehend the polarity of the nucleus. The arrangement of its molecules may be but an expansion of the principle of arrangement of the polar constituents of a neutral salt molecule. This has its acid and its basic pole; and we can imagine the molecules of the nuclear unit to be similarly arranged, not only with the acid and the basic poles of each turned in opposite directions, but with the molecules of acid affinity occupying one pole, and those of basic affinity the other pole, of the nucleus.

For this to be the case, however, some influencing agency is requisite, such as that of external chemical affinity. In short, the polarity of the nucleus may represent that of a galvanic circuit with active chemical affinity at each pole. The two poles of the nucleus may represent the acid and basic poles of such a circuit, and the nutrient material, the zinc and copper, or whatever other substances are employed. If such be indeed the character of the nuclear polarity we can comprehend various results which are now mysterious to us. The assimilation of nutriment by such a polar arrangement would be a strictly chemical process, the opposite poles taking up respectively basic and acid material. But the activity of this circuit, if dependant upon its own energies alone, must quickly come to an end through the satisfaction of the polar affinities and the chemical neutralization of the molecules.

At this point the agency of oxygen comes in. This energetic element attacks and partly breaks down the complex proteid molecules, and restores to them their lost affinities. Through its action the original activity of these molecules is regained, and they again vigorously attract the chemical radicals of the nutriment. Thus the probably small quantity of material carried off by every act of oxidation is perhaps replaced by the assimilation of larger and more complex molecules from the nutriment, and the protoplasmic mass grows in consequence.

This, of course, is all pure hypothesis. We are ignorant of, and perhaps may always remain ignorant of the facts that would

prove or disprove it. Yet we have no reason to doubt that the assimilation of nutriment is a chemical process; we know that the nucleus is a polar organization, we know that oxidation is essential to its activity, and that the chemical relations here supposed are in accordance with those that exist, or might possibly exist, in the active liquid of the galvanic battery. Thus the basis of the hypothesis is not unreasonable; and it may be shown that certain of its necessary results are strikingly in accordance with some of the most abstruse phenomena of organic life. If the hypothesis here advanced should prove a key to unlock the mystery of these phenomena, and the organic unit have in its chemical organization the essential elements of the most specialized life conditions, our hypothesis will certainly become worthy of consideration.

For such a polar arrangement of acid and basic molecules to be fully effective, it seems necessary that each pole should be in full vigor. Their energies mutually support and aid each other. Any check to the action of the basic pole, for instance, would check that of the acid pole. The chemical activity of the one is rendered possible by the chemical activity of the other, and there may take place an interchange of the constituents of the molecules like that supposed to occur in the water molecules of the battery. Hence the chemical activity of the nucleus would be controlled by that of its least vigorous pole, and for its fullest activity the poles must be equal in energy, and this energy be raised to its highest level of vigor.

As for the aid of oxygen in the process, it is not probable that the oxidation is an immediate accompaniment of the chemical action. Oxygen is constantly making its way into the organic cells, and it is probable that a slow oxidation continually goes on, its quantity depending upon the vascularity of the organ concerned. Under special circumstances, as of irritation of the nervous and muscular tissues, oxidation seems to become suddenly invigorated, and a considerable breaking down of the organic molecules takes place, with a vigorous discharge of energy. But every act of oxidation puts the nuclear molecules in a condition for active chemical assimilation, so that if the requisite nutrient material is provided, the loss is quickly repaired, and new proteid molecules, specially sensitive to the affinity of oxygen are produced. And so the wheels of life roll on, and growth replaces waste.

It might seem as if in such a process we had a provision for an endless life activity. The chemical energy of protoplasm, constantly quickened as it is by oxidation, appears capable of yielding an indefinitely large mass of material, so that the bulk and length of life of organisms might have no limits. Yet we are well aware that no such results take place, and therefore must believe that they are impossible. There must be some principle that checks both an indefinite increase in bulk and a ceaseless continuance of life.

There is such a principle, and the first step of its action is a check to indefinite growth of the nuclear unit. For the activity of this growth free access both of nutriment and of oxygen is necessary. But the oxidation to which growth is due quickly interposes a check to its activity. Some of the waste materials yielded by oxidation appear to remain within the nucleus. Others collect around it and form a mass which is known as the organic cell, of which the nucleus occupies the center. Evidently this process must oppose that of nuclear growth. With every exercise of chemical activity the mass of "formed material" around the nucleus increases in bulk, the access of oxygen and of nutriment is more and more hindered, and the nuclear energy is checked.[1]

There is only one method by which it can be regained. The waste material continues to cling firmly around it, and only by division of the mass into smaller portions can its nuclear center regain its former relations with the nutriment. This division takes place, and always through the nucleus. It might be imagined, indeed, that a vigorous effort was made by the polar constituents of the nucleus to reach the attractive nutriment, since division is always preceded by a strongly declared polar arrangement of its material, and it separates at its equator, its two original poles becoming the nuclear centers of two new cells. Growth energy is regained in these new cells, but its vigor is decreased with every successive division, for a reason now to be given.

[1] Part of the waste material is carried away by the nutritive current, and we can readily conceive of a condition in which all the waste is carried away, and the protoplasm left fully free to act. But such a condition is inconsistent with any high degree of organic development. Active protoplasm is necessarily semi-fluid in consistency. The retention of waste material is necessary to give consi-tency to the organism, and permit its increase in size and its organic differentiation. Some Protozoans are nearly pure protoplasm, but evolution in this direction must be soon checked by lack of solidity. For any extended development the protoplasm of the cell must retain around it some of its devitalized waste.

The ideas here advanced as to the constitution of the organic unit are not mere baseless supposition. This unit must be composed of chemical molecules, either identical or diverse in character. Their chemical activity seems to render a diversity more probable than an identity; but the apparent homogeneity of each unit seems to indicate that its molecules are not diverse in their chemical constitution, but only in their degree of chemical satisfaction. They must be either acid, basic or neutral in character, and very probably divergences in this respect occur between the molecules of every unit mass. But in mixtures of acid, basic and neutral molecules there might be great variations; here the acid, there the basic energy might be in excess. In other cases there might be a balance between these energies. Probably all these variations exist in organic units. Yet for the reasons we have here given, it seems probable that the unit mass in which the energies of the acid and basic molecules were balanced, would be best constituted for vigorous chemical action; and particularly so if these acid and basic energies diverged considerably from the neutral line. Such we conceive to be the constitution of a fully active chemical unit. But the process of cell division tends to diminish this activity.

For the separation of a nucleus into two halves, through its neutral equatorial region, must leave one of these halves with an excess of acid over basic vigor, and the other with an excess of basic over acid. The full energy of the acid pole remains in the one, in combination with a basic pole of reduced energy; and the same rule applies to the basic pole of the other. Thus the chemical energy of each must be less than that of the original unit. A second division adds to this effect. Of the acid half, for instance, after re-division in one of the new cells, the energy of the acid pole would be retained, with a basic pole still further diminished in energy; while in the other the two poles would return towards equality, but with diminished energy. This division must constantly tend to reduce the chemical energy of the cells.

A formula may aid in the elucidation of this principle. Suppose A———B stands for a normal unit, A and B representing the most vigorous acid and basic molecules, while the connecting line represents a mass of molecules becoming successively less strongly acid and basic, until neutrality is attained at the

equator of the mass. If now this unit be divided equatorially we obtain two new units, A———B and A———B. Their chemical energy is decreased, because each has a weakened pole. A division of the first of these new units will give us A——b and A——B. Here the first is thrown still more out of polar balance, while the second regains equality, but with diminished energy. And so on with continued division. We would obtain as the extreme terms of the process two cells, in one of which the full acid was accompanied by a greatly reduced basic vigor, and in the other a like advantage would be gained by the basic pole. Between these would be a succession of cells, less out of chemical balance, with one or more intermediate cells in which the balance of energy would be preserved. But in all these cells the vigor of one or both of the poles would be greatly reduced, so that the chemical activity must decline in vigor with every new act of division. Such a result is but an organic example of the principle we have already considered in inorganic nature, in the gradual separation of the constituents of sodium sulphate, Na_2SO_4. The molecules of the original cell would be represented by the mass of new cells into which it finally breaks up, some of these cells being specially acid, basic or neutral, as were the molecules of the normal cell.

In such a process we see the original strongly declared heterogeneity of the normal unit gradually diminishing, and chemical homogeneity approaching, while life vigor decreases in accordance. The process of division, which is necessary to keep up the activity of the cell, inevitably tends to diminish this activity from a secondary cause, that of loss of chemical heterogeneity. How shall this essential condition be restored, and the full activity of life action be reproduced? Evidently by a reversal of the process above considered. If cell division reduces the life energy, cell combination may restore it. If, for instance, the two extreme terms of such a continued division be reunited, all the lost chemical heterogeneity would be regained, and the normal condition reproduced. Let the two extreme units, A——b and a—B, join to form a new unit; we would have as result A———B, the intermediate polarities falling into place between these polar extremes. Thus by a single process of combination a cell would be gained possessing all the chemical heterogeneity, the polar balance and the vital activity of the original.

And such a result must very strongly tend to occur, from the vigorous attraction between acid and basic chemical radicals. Many other unions might take place, between the remaining cells of the continued division. Thus the final result of the division of a single normal cell, would be the reproduction, from the union of its many daughter cells, of numerous normal cells, differing perhaps considerably in their degree of homogeneity, and in the completeness of their polar balance, yet each capable of setting up a new life cycle.

If now we give this polarity another name, and call it sexual polarity, new light may be thrown upon the life problem. Life is continuous, but not in the individual. The individual tends towards chemical inertness and final death. The continuity of life exists only in the race; and such, under our hypothesis, must be the law governing the development of the organic life units. Division, which is their only available method of continued growth, brings them more and more towards chemical inertness and loss of vitality. Reunion of oppositely polarized germs, which have arisen from the original individual, restores the life activity by the production of a new vitalized individual. The life energy, failing in the individual, is restored in the race.

If we replace the words acid and basic polarity by male and female polarity, the cycle of life opens out before us. A normal unit or germ possesses balanced male and female energies. Continued division produces a multitude of new cells, some with an excess of male, some of female energy. As either energy weakens, the life energy of the new unit weakens. Each of these cells is a male or a female germ. The union of two of opposite sex produces a fertilized germ, in which the balance of male and female energies is restored, and which is, therefore, capable of setting up a new cycle of development. All that we know of the life development of Protozoan animals is in accordance with this hypothesis. And evidently, if the sexual polarities were balanced in the original Protozoan, they must be balanced in all its descendants taken as a whole; so that the degree of opposite polarities, and the numbers of each sex, must continue equal. And as in the reunion of germs, it is highly improbable that out of the vast numbers produced, two of exactly balanced sexual polarity should meet, therefore the new individuals are very likely to be specially male or female in condition, possessing some excess of acid or basic energy in their chemical organization.

[*To be continued.*]

THE ORDER OF THE UNIVERSE.

BY W. N. LOCKINGTON.

I. MONISM *v.* DUALISM.

ONLY two complete theories of the origin, nature and preservation of the universe have as yet been presented. The first of these, monism, assumes the essential unity of the universe. Everything within the universal bounds, from the tiniest particle to the hugest globe; from the earth on which we poor reasoners dwell to the farthest star in heaven's vast galaxy; from the heaviest metal to the most etherealized interstellar medium, is by this theory conceived of as consisting of but one substance, to which, in the poverty of our human speech, we have given the name of "matter," and to all whose manifestations, qualities or properties, by which we are cognizant of its existence, we give the name of "force."

The second or dualistic theory accepts matter as it finds it, and to a certain extent admits that matter is possessed of qualities or gives out manifestations which may be called force; but in order to explain the existence of matter, assumes, entirely outside of material existence, a second principle, which existed before matter, created that matter, endowed it with force, and is itself directly active in the highest manifestations of force exhibited by material organisms.

Monism asks it disciples to believe many things which, to the understanding of the highest outcome of this earth's activities, are as yet incomprehensible. The formation and preservation of suns and planets; the molecular motions and structure of inorganic materials; the origin, nature, continuance and variation of life, have all to be conceived as emanating from matter by the action of its own inherent force.

Dualism escapes these difficulties—strikes them out with a word by one vast assumption. An immaterial, or rather non-material agency accounts not only for all the manifestations of force, from that which forms a crystal to the highly developed consciousness of the wisest man, but for the very existence of matter itself. The difficulty left is to account for the origin, nature and continued existence of the assumed creative power, and for the manner in which it was able to form matter out of preëxistent nothing.

The majority of men in all ages, and most of the accepted religions of mankind, have adopted the dualistic theory. By it the mind of man was relieved from all speculations regarding the nature of the material universe, every ordinary occurrence was referred to the action of a creative and preservative force, and extraordinary phenomena were unhesitatingly ascribed to a more direct agency of that force.

But the spirit of inquiry is natural to the human mind, when it is not distorted by education or paralyzed by sloth. Certain results were observed to follow certain causes with unerring regularity, whether in the broad domains of astronomy or in the narrow limits of human activities, and confidence in these results became so unbounded that men in their daily life, while theoretically believing in an omnipotent and omnipresent power, based all their actions upon the known properties of material things. This dual code of life is that observed throughout Christendom at the present epoch, and causes strange eccentricities.

To explain this inconsistency, the idea of law arose. The omnipotent, all-knowing power which made matter and gave it its properties either cannot (a contradiction) or will not change those properties. Laws once made were conceived to continue either by the properties originally impressed upon matter by its creator, or by the continual preservative power of that creator, exercised invariably according to certain fixed rules which he has made for himself, and according to a prearranged design which he has proposed to himself to work out.

Under this phase of dualism, a belief in any departure from the known laws of matter becomes an improbability amounting almost to the impossibility of such departure which is the logical result of the monistic view. This elimination from the order of the universe of any present interference of a creative power, reduces that power to the position of a passive spectator, or, at most, of an executor of laws framed in the far past, and is, therefore, rightly regarded by rigid dualists as a great concession in favor of monism.

A dualist conceives consciousness, or the soul, to be a direct emanation from the deity, imprisoned for a certain time within material bonds, but prompt at its liberation to return either to the God who gave it or to the punishment provided for it in consequence of its misdeeds. To account for the existence of evil, the

idea of deity has also been made dual, including a good and evil principle, at war with each other. The evil principle, though nominally the weaker, is, in the current belief, allowed to succeed in the ruin of the future of the great majority of individual souls. Thus a dualist has at least a definite philosophy, one which, however it may be doubted, can never be disproved; and one which, however it may be believed, can never be proved.

Leaving dualism for a while, let us consider how monism can explain consciousness; let us see if it has yet fixed upon a definite theory.

II. Matter, Force and Consciousness.

The exigencies of language compel us to give names to express ideas which are not things, and it is a tendency of the human mind to figuratively speak of these names as though they were objects, and too often to conceive of them as actual objects. The word "matter," in the strict monistic sense, must include all properties exhibited by matter just as surely as the name "man" must be held to include all the physical and moral properties of man. Just as justice is an abstraction of our language put instead of "the state of being just," so is force an abstract term meaning "the state of being forcible," and consciousness an abstract noun meaning "the state of being conscious." The latter word is in its very shape clearly a nominal form of the adjective conscious, but in the case of force it is less easy to define, since the adjective "forcible" is commonly held in a more limited sense than the noun force, which is usually adjectived by the words "potential" and "kinetic" (actual), dependent upon whether the matter having force is using that quality internally or externally. "Latent heat," "potential energy," and other similar phrases, must be held simply to mean that a certain quantity of matter, not at the moment exhibiting heat or energy to our senses, may, under changed conditions, be made to do so, whilst "sensible heat" and "kinetic energy" mean the exhibition of those properties to our senses by portions of the universal matter.

But there is a particular exhibition of force, residing only in certain complex and unstable compounds, which differs so widely from other forces that we are compelled to give it a distinct name —consciousness. Unable to explain how consciousness can be produced, yet forced to acknowledge that it has never been met

with apart from matter, some monists conceive of it as an independent thing, which is, however, unable to manifest itself except through matter. Such a belief is simply a degradation of the supernatural half of a dualist's belief. According to it, that which to a dualist is the soul, the emanation from an omnipotent deity, is a slave of matter. Such conceptions arise from the gross ideas of matter that have so long prevailed. The true conception of matter is "everything that exists." Under the monistic idea, as under the dualistic, the belief in supreme and subordinate spirits may exist, but the spiritualist who is a monist must concede the materiality of his supposed spirits. Under the monistic idea a future life is as possible as under the dualistic, but future consciousness must be accompanied by the matter which exhibits it, and the future existence of an individual must be a mental continuation of his present mentality. The Buddhistic idea of Nirvana, or of a state of generalized blessedness, an absorbption into an ocean of conscious matter, may be logically held by a monist; whether he can find peace in believing in an eternity of existence, coupled with annihilation of individuality, is another question. To be consistent, every monist must, when he speaks of consciousness, use that term in an abstract sense, as a certain force-quality of highly organized matter.

To conclude, the shades of belief possible are almost endless, and the positive proof or disproof of most of them is impossible. It would be well, therefore, for all who have the slightest claim to the possession of a high degree of consciousness, who claim to be intelligent or civilized, to make a broad distinction between proved facts and theoretical doctrines, and to have too much charity to be prejudiced against, and still less to discriminate against, those whose honest doctrines differ from their own. At the same time the faith of the truly scientific mind will be in harmony with proved facts, and he will be at any time ready to surrender a belief in deference to such facts.

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EDITORS' TABLE.

EDITORS: A. S. PACKARD, JR., AND E. D. COPE.

—— The mortal remains of Charles Darwin lie by the side of those of Sir Isaac Newton, in Westminster Abbey. A great nation in doing homage to the name and fame of the world-renowned naturalist, has thus expressed its judgment of the true place he

should take among those philosophers and students who have done it greatest honor. The feeling thus expressed, that Darwin should rank with Newton, Faraday, and other scientific leaders, is shared by the best judges of the work he has done in remodelling scientific thought, and in originating and completing the revolution in biological methods, which has been effected within the last quarter of a century.

As a physical geographer, as a systematic zoölogist, and as an anatomist, as well as palæontologist, whatever Darwin accomplished was of a high order. But it was not in these departments of science, that he excelled. He was most eminent and original in observing the habits of plants and animals, their relations to each other and to their surroundings; he studied the variations of species under domestication and in a state of nature; he studied hybridity, and especially the effects of heredity and growth force. He did little work in comparative anatomy, and almost nothing in embryology, but the influence his ideas exerted upon these difficult fields of research, have stimulated the development of these sciences to a wonderful and unprecedented extent.

Darwin pursued the objective or inductive method. He approached the subject of evolution, rather from the biological point of view, from a study of the living organism, than from the embryological and palæontological side. He was cautious in observing, collating, and arranging his facts, which were proved by experiment and tested again and again. With a broad foundation of facts, he could afford to make brilliant deductions and bold speculations. Some phases of his theory of natural selections may be unproven hypotheses, and his own theory may be emended and greatly extended, but the world remembers Newton's theory of gravitation and forgets his crude theory of light. Darwin showed admirable caution, self-criticism, candor, and an absence of the controversial spirit. He gave credit to those to whom it was due, and the charge of appropriating the work of others has never been breathed in connection with his name.

Moreover, his clear, simple, lucid style, his powers of exposition and rapid generalization, caused his books to be read by the layman as well as by the scientist. His works and views never needed an expounder.

Under all these conditions, Darwin was his own intellectual executor. He gave his theory to the world, and lived to see it become the common intellectual wealth of his own age. Within twenty-two years after the appearance of the "Origin of Species" his opinions gained the mastery of the philosophic and scientific field of thought.

This was mainly the result of his methods, the Baconian or inductive. The *à priori*, purely metaphysical or philosophical methods of Herbert Spencer are not convincing to the most of

naturalists. But the solid array of facts which Darwin marshaled in orderly lines, carried force and conviction to every unprejudiced mind. It was partly for this reason that the views of Goethe, and St. Hilaire as well as Lamarck, did not gain universal sway and that they were temporarily overthrown by Cuvier and his school with their exact analytical methods.

But Darwin appeared in the fullness of time. Biology and geology with their subordinate departments of palæontology, embryology, and histology had, after Lamarck's and Cuvier's death, either originated or immensely developed, and the time had arrived for synthetical methods and speculative views.

Enough was known of the 100,000 species of plants and the nearly half a million species of animals now living, and of their relations to each other and to former worlds, to warrant the naturalist in attempting a solution of the question as to how they all appeared.

The result of such inquiries has already been fruitful and happy. It has been given to the intellect of man to attempt a solution of their questions, and the mere attempt, as the result proves, has elevated and drawn out man's intellectual powers in a new direction. Many have aided in this work, but as the leader and successful originator of the new school of evolutionial thought, all will ascribe to Darwin the highest position. His was an epoch-making mind.

Darwinism, as such, *i. e.* the theory of natural selection, expresses the ultimate cause. We have yet to demonstrate the evolutionary laws which originate the tendency to variation from which natural selection takes the start, and naturalists in the future will ascribe more to the effects of the environment upon the organism. But the sterile methods and subjects of study pursued before the year 1860, have been for the most part abandoned. New light has been thrown on old facts, and Darwin has sowed the seed, from which a rich intellectual harvest will be reaped by coming generations.

Charles Robert Darwin, the grandson of Dr. Erasmus Darwin, was born Feb. 12, 1809. After taking his degree at the University of Cambridge in 1831, at the age of twenty-two, he sailed with Captain Fitzroy, of H. M. ship *Beagle*, as volunteer naturalist in the survey of the coast of South America. Returning from his voyage around the world in 1836, he published, in 1839, his "Journal of Researches into the Geology and Natural History of the countries visited during the Voyage of H. M. S. *Beagle* round the World." In 1840–42 appeared his "Zoölogy of the Voyage of the *Beagle*"; and rapidly succeeded his works on "Coral Reefs," (1842), on "Volcanic Islands" (1844), and "Geological Observations" (1846). His most finished systematic work was his "Mono-

graphs on Cirripedia" (1851–53). His anatomical, systematic and palæontological work was all equally thoroughly well-done.

He then matured his views as to the origin of species, suggested by his observations on the South American coast, particularly by "certain facts in the distribution of the organic beings inhabiting South America, and in the geological relations of the present to the past inhabitants of that continent." The "Origin of Species" was issued in November, 1859, and was designed as an abstract of a more extended work.

Then appeared in rapid succession his "Fertilization of the Orchids" (1862), "Habits and Movements of Climbing Plants" (1865), "The Variation of Animals and Plants under Domestication" (1867), "Descent of Man" (1871), "The expression of the Emotions in Man and Animals" (1872), "Insectivorous Plants (1875), "The Different Forms of Flowers and Plants of the same Species" (1877), "The Effects of Cross and Self-fertilization in the Vegetable Kingdom," and "The Power of Movements in Plants" (1880). His last book was "The formation of Vegetable Mould through the action of Worms, with observations on their habits," which appeared in 1881. He also contributed numerous papers to the scientific journals. His own works may be said to have created a new department of literature.

After his return from his travels, he lived at Down, Kent, where he died. For many years his health had been precarious, and only a strong will, great powers of application, and his rare genius, enabled him to accomplish so vast and varied an amount of work.

Darwin married in 1839, and left five worthy sons and two daughters. His life was a happy and peaceful one. His nature was genial and devoid of the controversial, self-seeking spirit. The great philosopher and naturalist died, though full of years and scientific honors, yet almost prematurely, mourned by the intellectual and scientific world.

—— If it be admitted that effort and use lie at the foundation of development, it is important that the stimuli to effort and use should be preserved intact. The first great stimulus, both in importance and in order of time, is hunger. The second great stimulus is the instinct of sex. These two impelling forces lie at the foundation of the activities of man, as well of the inferior animals. A modern school of evolutionists believes that not only the machinery of animals has been built by these forces, but the mind itself has been by them elaborated from these forms of simple consciousness in conjunction with memory.

The mental faculties are divided into the intellectual (including rational) and the affectional classes. It is thought that the rational faculty has been developed by all kinds of experience, into which their necessities have continually forced living beings.

The affectional or emotional qualities have been developed in the same way. The especially beneficial emotion is that of sympathy, or the love of other beings than self, and this it is thought has been evolved from the primitive sexual instinct. Darwin has pointed out how sexual selection has probably effected development of purely bodily perfections, as in the cases of the brilliant plumage and musical voices of birds. He very significantly calls his book on sexual selection, "The Descent of Man."

That the rational faculty cannot be too much developed, goes without saying. It is also evident that the affections or sympathies should be developed sufficiently to produce a desire for the happiness of others, through the pleasure the happiness of others gives us. A lack of sympathy is as great a defect of character as is the lack of rationality.

The question for society then is, what are the best methods of developing the two foundation elements of character, rationality and sympathy. These qualities check each other in practice, and form the two sources of happiness.

If custom imposes on either sex any disability by which its development in any respect is curtailed, the race of both sexes suffers injury. It suffers in two ways:

First, by defective inheritance by children.

Second, through inequality in the sexes themselves, and consequent lack of mutual sympathy and interest.

I. Of course children are more or less influenced in their mental constitution by that of the mother, and we shall never have an ideal race until mothers are developed as much as possible. We speak of mothers because custom does not supply to them the same stimuli to intellectual exercise as it does to men. Some professional men have even permitted themselves to express the idea that the education of girls interferes with their physical development. We are loth to believe that this is a necessary state of things; if it be so in some instances, it is to be hoped that it is a temporary condition of race or family, and one to be remedied by future experience. There is also no doubt a lingering fear in some minds that intellectual women may be less women than are ignorant and thoughtless ones. The supposition that education can make a woman anything but a woman, can only be entertained by persons unskilled in zoölogy. It has been pretty conclusively shown by Broca and others, that a greater divergence or specialization of the sexes is consequent on civilization, as in evolution generally; and it would seem to be entirely within the range of our power to determine whether this diversity shall or shall not include an atrophy of the rational faculty in women.

II. The effect of education of both sexes is to enhance their interest in each other, and the relation is ennobled in direct proportion to the amount of mental sympathy which exists between

them. It is to be doubted whether this field for the increase of happiness is as much as suspected by very many persons. One of the first conditions of the stability and harmony of society is the correct working of the double-headed system on which it has been created. It cannot be denied that the greater the amount of interest invested in this system, the more secure it must become. The stimulus which intelligent people bring to bear on each other is very great, and where this comes from a person in whom the affections are deeply interested, the force is greatly multiplied. It is self-evident that the effects of this force must be seen in the race, and that it is one powerful agent in progressive evolution. It acts especially in times of prosperity, when the pressure of the struggle for physical existence is diminished. It assumes especial importance when the impetus derived from the latter source diminishes, and is the best guarantee of future progress at such a time. Any agency, therefore, which effects the development of one sex, is a blessing to the other.

Is the present constitution of Christian society the best for the maintenance and development of the highest qualities of the mind? It is evident that the monogamic system will be preferred in proportion as the mental constitution of the sexes adapts them best to each other's needs. The rational education of women is not in the interest of polygamy; and the development of the higher affections of men is equally in the direction of monogamy. Monogamy in a community is doubtless in direct proportion to the development of its members in rational and sympathetic qualities. But sexual selection has but imperfect opportunities where there is little to choose from in the poórer classes; and where there are conventional standards of excellence in the richer classes. The problem is, how to secure a just regard for the far-reaching law of sexual selection, consistently with a maintenance of the monogamic relation. General culture will do much towards placing the solution in the hands of every one, and toward producing any modification of existing customs which may be necessary.—*C.*

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RECENT LITERATURE.

VOLCANOES.[1]—The recent activity in the study of volcanism, with the erection on Mt. Vesuvius and Mt. Etna of observatories for the observation of volcanic phenomena, and of eruptive rocks by new methods of research, has called for a popular work treating of this subject in a simple and yet comprehensive way. These conditions have been met by the author, who is a friend and disciple of the late Mr. Poulett Scrope. The volume pre-

[1] *The International Scientific Series. Volcanoes: What they are and what they teach.* By JOHN W. JUDD, F.R.S. With 96 illustrations. New York. D. Appleton & Co. 12mo, pp. 381.

sents little matter subject to criticism except from those who may oppose some of the writer's views on metamorphism, a matter regarding which there is naturally much difference of opinion. After describing the nature of volcanic action, well illustrated by the eruption of Vesuvius in 1872 (Fig. 1), which, with that of

FIG. 1.—Vesuvius in eruption, as seen from Naples, April 26, 1872.

1858, was probably more carefully observed and photographed than any previous outburst, the work treats of the products of volcanic action, the distribution of the materials ejected from volcanic vents, with the various structures built up around them, as

also the internal structure of volcanic mountains and their distribution over the earth.

The nature of lava overflows and the causes of the differences in their rate of motion are well discussed. The accompanying illustration (Fig. 2) of a lava stream which, from its imperfect fluidity in flowing over the edge of a precipice, forms heavy pendant masses like a "guttering" candle, is a fair example of the quality of the woodcuts.

The volcano from which all our pumice-stone comes is represented by Fig. 3. How this is formed is well told. By experiments with sawdust thrown up by an air-blast, the structure of volcanoes formed of scoriæ, pumice and other fragmental materials is illustrated.

"Many cones formed in the first instance of scoriæ, tuff and

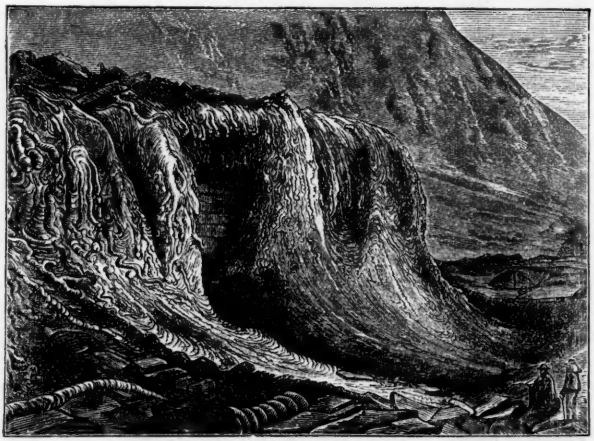

FIG. 2.—Cascade of lava tumbling over a cliff in the Island of Bourbon.

pumice may give rise to streams of lava, before the vent which they surround sinks into a state of quiescence. In these cases, the liquid lava in the vent gives off such quantities of steam that masses of froth, or scoriæ, are formed, which are ejected, and accumulate around the orifice. When the force of the explosive action is exhausted, the lava rises bodily in the crater, which it more or less completely fills. But eventually the weaker side of the crater wall yields beneath the pressure of the liquid mass, and this part of the crater and cone is swept away before the advancing lava stream. Examples of such 'breached cones' abound in Auvergne and many other volcanic districts. A beautiful example of a cone formed of pumice, which has been breached by the outflow of a lava stream of obsidian, occurs in

the Lipari islands, at the Rocche Rosse (Fig. 3). It is this locality which supplies the whole world with pumice."

FIG. 3.—Campo Bianco, Island of Lipari. A pumice-cone breached by the overflow of an obsidian lava-current.

To the general student the closing third of the book will commend itself. The writer successfully applies the doctrine of continuity to volcanism and volcanic rocks. He claims that the granites formed in Tertiary times present no essential points of difference from those which originated in the earlier periods, and that the same materials may, under different conditions "assume either the characters of granite on the one hand, or of pumice on the other." Professor Judd assumes that "the careful consideration of all the facts of the case leads to the conclusion that when pumice, obsidian and rhyolite are now being ejected at the surface, the materials which form their substances are, at various depths in the earth's interior, slowly consolidating in the form of quartz-felsite, granite-porphyry and granite," and after farther discussion, he concludes "that the manifestations of the subterranean forces in the past agree precisely in their *nature* and in their *products* with those taking place around us at the present time." We are then led to the subject of the formation of mountain chains, which are happily termed "cicatrised mounds in the earth's solid crust." He then epitomises the leading events in the formation of mountain chains.

"A line of weakness first betrays itself at a certain part of the earth's surface by fissures, from which volcanic outbursts take place, and thus the position of the future mountain chain is determined. Next subsidence during many millions of years permits of the accumulation of the raw materials out of which the mountain range is to be formed; subsequent earth-movements cause these raw materials to be elaborated into the hardest and most crystalline rock-masses, and place them in elevated and favorable positions; and lastly, denudation sculptures from these hardened rock-masses all the varied mountain forms. Thus the work of mountain making is not, as was formerly supposed by geologists, the result of a simple upheaving force, but is the outcome of a long and complicated series of operations."

What volcanoes teach us concerning the nature of the earth's interior is given in a clear, interesting way. The "crust of the earth" is, as geology now shows, only that part of a solid globe accessible to examination, and the interior may consist of materials similar to those found in meteorites, while the volcanic phenomena witnessed on our earth may be identical in nature with the great movements in other worlds than ours."

BRUNTON'S BIBLE AND SCIENCE.[1]—The author of this excellent book makes a very successful attempt to reason with those who regard the doctrine of evolution "with horror mingled with fear." He gives a brief, popular and very readable sketch of some of the data on which the doctrine is founded, and shows "that instead of

[1] *The Bible and Science.* By T. LAUDER BRUNTON, M.D., F.R.S., with illustrations. London, Macmillan & Co. 1881. 12mo, pp. 415. $2.50.

being atheistic it is the very reverse, and is no more opposed to the Biblical account of the creation than those geological doctrines regarding the structure and formation of the earth's crust, which were once regarded as heretical and dangerous, but are now to be found in every class-book, and are taught in every school."

The three first chapters are excellent examples of a common-sense interpretation of some of the events recorded in Genesis and Exodus in the hyperbolical and oriental language of a childish age of mankind, and they are written in a most interesting, graphic style.

In lecture XVI on the Mosaic Record and Evolution, Dr. Brunton thus carries his readers in the following manner across the—to paraphrase a Latin expression—*pons simiarum:*

"But by far the most serious objection to the hypothesis is its necessary extension to man. If we accept it, we must give up the belief which we all learned in our childhood, that a single man was created out of lifeless mud, became a living soul, and was the progenitor of the whole human race. We must believe, instead, that men are descended, not from any of the species or genera of monkeys now living, but from creatures which were the common ancestors of man and monkeys, and much lower in the scale of existence than either. If such progenitors existed, they were probably somewhat like the lemurs of the present day, though still lower in the scale of existence than they. From these hypothetical common ancestors of man and monkeys, two different races started. Man developed onwards towards greater and greater intellectual powers; he learned to light fires, and gained all the power which this could give him; learned to communicate with his fellows, not merely by verbal signs, but by visible ones, either in the way of drawing or writing, and thus was enabled to pass on the accumulated knowledge of one generation to another. The monkeys on the other hand, developed rather physically than intellectually, they became admirably adapted for an arboreal life, but the satisfaction of their hunger, or the gratification of their other appetites, were the utmost ends to which their mental development enabled them to attain. Believers in evolution do not, however, fancy that a monkey can now become a man, or that monkeys of the present day can ever develop into men; for between men and monkeys there is a great gulf fixed. They may have started from a common point long ago, but the races have now diverged so far that it is perfectly hopeless for the one ever to pass into the other.

"The doctrine of a common descent of man and monkey from some lower animal, seems at first sight to cut at the root of all religious beliefs. But again we must ask the question, does it do so? Many people seem to believe that, according to the theory of evolution, men are monkeys, because men and monkeys are descended from a common ancestor. But this is not the case. A

man is a man, and not a monkey, whether his first progenitors became men by special creation from a lump of clay, or whether they were developed from a man-like animal. We are not pagans, robbers, murderers, manstealers, living by rapine and dealing in bloodshed, and yet it is almost certain that we are descended from ancestors who were pagans, robbers, murderers, and manstealers, nor does it matter now whether these our ancestors were suddenly changed from heathen pirates to Christian herdsman and agriculturists, or whether a generation or two elapsed during the change. The change has taken place, and that is enough."

The author then argues that though we are reasonable beings, we were not always so, *i. e.* in early infancy, and hence he claims "the difficulties regarding the passage from an animal to a man, and the possession of a soul are the same in the case of the individual man as they are in the case of the race."

We would recommend this book to the general reader, while parents and teachers will find in the last chapter on the "Development of Individuals," some practical hints as to the care of children.

The author's views are expressed with so much earnestness, simplicity and attractiveness, that we feel sure the book will be widely read. It is, in spite of some points which might be criticised, the best of the sort which has yet been published, and deserves wide circulation.

CHAUTAUQUA TEXT-BOOKS, No. 22, BIBLICAL BIOLOGY.[1]—Forty-one pages of false science mingled with true, the better to suit the babes who suck at the Chautauqua milk-bottle. The tract would not be worthy notice were it not for the contemptuous tone adopted by the clerical writer towards scientists who, since they are not clerical, have freed themselves from the slavery of clericalism. "Cobbler, stick to your last," is good advice to all clergymen, who, though interested in some branch of biology, go out of their way to depreciate those whose broader view enables them to discern the tendency of proven facts. Every non-evolutionist that works in biology is heaping up facts to his own condemnation.

After a tilt at monism, at Bichat, at Carpenter, and at Herbert Spencer, the author quotes the Rev. Jos. Cook. He then tries to squeeze help out of Huxley, notwithstanding that writer's known tendencies in an opposite direction.

In the teeth of all the facts that prove that living beings are constantly changing, changing even in a few years, while one man's eye can watch and record the changes; in the teeth of the shading of variety into species; of the production of generic characters by a slight acceleration or retardation under changes of environment; in the teeth of proofs as clear as those on which

[1] *Chautauqua Text-books.* No 22, Biblical Biology. By Rev. J. H. WYTHE, A.M., M.D.

the Copernican system is built, and in the teeth of the evolution of his own race during his own life, Dr. Wythe dare not only assert that "transmutation is impossible," but brands with the name of "Atheist," such men as Spencer, Wallace, Tyndall, Huxley, Darwin, Quatrefages, Cope and Draper, men whose reverence for all that is good, and honest hatred of all that is evil or hypocritical is evident in every line of their writings. Dr. Wythe does not know, or forgets, the fact that the teachers of a newer and better creed are always called atheists by the bigoted adherents of an older and worse one. His list of dualist naturalists consists in great part of the mighty of the past, and of men whose laurels have been won in non-biological fields, and whose claim to the title of biologist consists chiefly in their conservative opposition to the lessons biology teaches.

Then comes the old argument that, if transmutation be true, in the struggle for existence, all the lower should have been changed to higher forms. By the same reasoning, if civilization be true, all savages should have reached the highest civilization. But savages exist, and Dr. Wythe will not deny that they are of the same species with himself. Ergo, civilization is not true.

We refer, as a curiosity, to the paragraph on "spiral motion or fiber" *(sic)*, which the author declares to be a "wonderful thing." Even spiral motion without "fiber" is a "wonderful thing" according to the definition given, which is as follows: "For all circular movement two forces are needed, centripetal and centrifugal, but for a spiral, a progressive movement of the centrifugal point is also necessary." When we read the list of these movements we increase our wonder. They are "cyclosis and spiral fibers of plants, phyllotaxis, spiral forms in shells and radiates, the spiral movement of the moon and planets in space, and many spiral nebulæ."

The classification of our author is better than might be expected, indeed, in some points it is that of the "atheistic" Haeckel, but it is significant that the echinoderms are retained among the radiates, that the troublesome types of Vermes are ignored, and that *man is not included in the vertebrates.* Shades of Cuvier and Agassiz, what think ye of him who claims to be your follower?

DARWIN'S FORMATION OF VEGETABLE MOLD THROUGH THE ACTION OF WORMS.[1]—This, the last of Mr. Darwin's works, is characterized by the same patient observation, ingenuity in methods of research, cautious spirit and powers of generalization, which may be seen in his more important works. The startling conclusions of this book are gradually approached, and each step is so

[1] *The International Scientific Series. The Formation of Vegetable Mould through the action of Worms, with observations on their habits.* By CHARLES DARWIN LL.D., F.R.S. With illustrations. New York, D. Appleton & Co., 1882. 12mo, pp. 326. $1.50.

surely taken that the reader at the end is convinced that the results derived from so many facts must be well founded.

In 1837, in a short paper on the "Formation of Mould," the author showed "that small fragments of burnt marl, cinders, &c., which had been thickly strewed over the surface of several meadows, were found, after a few years, lying at the depth of some inches beneath the turf, but still forming a layer." This was due "to the large quantities of fine earth continually brought up to the surface by worms in the form of castings." This subject has been faithfully followed up through a period of over forty years.

After describing the structure and habits of the earth-worm, Darwin shows that they burrow both by pushing away the earth on all sides, the pharynx being, as Perrier had shown, pushed forwards into the end of the head, causing it to swell out, and thus push the earth away on all sides, while also the worm swallows the dirt, which passes through the body. In this way worms may penetrate to a depth of from three to eight feet. By their great numbers and continued activity earth-worms bury small, and often great stones left on the surface. In many parts of England it is estimated that a weight of more than ten tons of dry earth annually passes through their bodies and is brought to the surface on each acre of land; so that the whole superficial bed of vegetable mold passes through their bodies in the course of every few years. Moreover they triturate and thus disintegrate particles of rock, and thus aid in the denudation of land. By their action ancient earthworks and tumuli are lowered, and old ruins, pavements and stone walls are either buried or perceptibly lowered, and thus the humble earth-worm acts in the end as a not unimportant geological agent.

THE MICROSCOPE IN MEDICINE, BY LIONEL S. BEALE, M.B., F.R.S.[1]—This is the fourth edition of a well-known and valuable work, by one of the most practiced microscopists of the United Kingdom.

The introduction consists of an able plea for encouragement and assistance in the scientific investigation of disease, and is followed by nearly 200 pages devoted to a description of the apparatus necessary for the examination of objects of clinical importance, the practical operations required for their demonstration, and the methods of recording the appearances observed.

In this portion of the work full directions are given for hardening, boiling, freezing, rendering transparent or opaque, preserving, mounting, coloring, cutting sections, injecting, and other processes necessary for the examination of the various kinds of

[1] *The Microscope in Medicine*, by LIONEL S. BEALE, M.B., F.R.S., Fellow of the Royal College of Physicians, etc., Fourth Edition, pp. 528. Illustrations more than 500, most of which have been drawn on wood by the author. London, J. and A. Churchill; Philadelphia, Lindsay and Blakiston.

healthy and morbid tissues, both hard and soft, and the letter-press is aided by twenty-four plates.

The second and larger part treats of the microscopical characters of the simplest particles of tissues and of their demonstration; of structural elements and elementary parts in health and disease; of deposits from fluids, and of animal and vegetable parasites. After a chapter devoted to the living matter and cell-structure of organizms the author treats of lymph, chyle, blood and serous fluids, of medico-legal investigations, saliva, sputum, vomited matters, fæces, discharges of various kinds, and milk. Pus, animal poison or virus, contagium, and tubercle, are next considered, and the author's views of their nature fully stated; the urine, and urinary deposits and calculi, are next examined into, and the remaining portion of the work, except a short chapter devoted to human parasites, is taken up by methods of investigation of the various tissues and organs of the body in health and disease, and statements of the author's opinions of the nature of diseases affecting them.

In a field so broad as that covered by this book there is of course much room for difference of opinion. Dr. Beale devotes much of his space to theories of his own, more or less ably supported by argument; and to the disproof of rival theories.

His opinion upon the value of the microscopic examination of blood-stains in cases of supposed murder, based as it is upon the great resemblance of the red blood corpuscles of the carnivora, some ungulates, rodents, quadrumana and certain other mammals to that of man, and upon his own extensive practice, is entitled to great weight. He says, "I can hardly think that in any given case the scientific evidence in favor of a particular blood-stain being caused by human blood, will be of a kind that ought to be considered sufficiently conclusive to be adduced, for example, against a prisoner upon his trial." He, however, considers such evidence as of value in strengthening or weakening other circumstantial evidence.

Against all theories of disease that refer the contagion to germs of fungi or bacteria, Dr. Beale decides unhesitatingly and argues, in our opinion, almost convincingly. He does not by any means stand alone. Dr. Benjamin Richardson has long advocated very similar views, and although the adherents of the "germ" theory have of late years made a far greater show in print than their opponents, it has been through the remissness of the latter rather than on account of the powerful arguments of the former.

That bacteria, vibrios, etc., are found in abundance in all those diseases called zymotic, is undeniable, but it is also true, as Dr. Beale asserts, that "many things we eat contain them in countless multitudes. In the alimentary canal of infants suffering from a little stomach derangement, bacteria are often present in vast num-

bers * * * * many of the secretions may contain them without perceptible injury to the health, while hosts of them are invariably present in the fluids, and in and about the superficial cells of the mucous membrane of the mouth of all persons, even in the most vigorous health." All fungi and schizomycetes feed upon decaying organic matter, and therefore their presence does not prove that they are the cause of the disease. The assumption of a different species of bacterium to each disease is not warranted by our present knowledge of these low existences, and if, as our author asserts "the virulence of the virus decreases as the bacteria in it increase in number," the bacterium theory seems scarcely tenable. Dr. Beale asserts that he has never been able to discover a bacterium in pure vaccine lymph, and that those who regard the solid particles found in vaccine as bacteria commit the grave error of confounding the actual contagious "bioplasts," derived from the living matter of the cow, with bacterium cells, from which they differ visibly in the want of regular form and the absence of a cell-wall. Dr. Beale believes the contagium or virus of every contagious disease to consist of extremely minute particles of the *living* matter of the species infected by the disease. This contagium is "bioplasm" become poisonous, and "each kind of contagious bioplasm manifests its own specific actions, and only these." He admits, however, that such particles cannot, in the present state of our knowledge, be distinguished from healthy particles of the same size; and he also admits that it is remarkable that one form of disease has always been found accompanied by a specific organism that has not been found in any other.

May not the truth lie between the two opposing schools, and, although the great majority of diseases are caused by organic changes in the protoplasm or in the secretions (Dr. Richardson's theory) of the infected species, may not a few, especially those which are localized in their manifestation, be caused by microscopic organisms? We know that the entozoa sometimes produce positive disease, and that certain skin diseases are caused by acari—why then may not certain lower existences be poisonous, and cause some of the less common forms of disease?

Dr. Beale asserts that the pus corpuscle or globule has no cell-wall, and that "the bioplasm of tissue, being supplied with an increased quantity of pabulum, may give rise to pus." A too rapid multiplication, resulting in the formation of particles that have lost the power of forming tissue, is, in Dr. Beale's opinion, the origin of pus. Tubercle, he asserts, can be microscopically shown to consist of small protoplasmic masses of about the size of a red blood corpuscle, these particles are living, and grow, but more slowly than pus corpuscles, from which they differ also in their firmer consistence. Thus there is a tendency to heredity, yet tubercle may be developed by bad hygienic conditions in persons free from hereditary taint.

Morbid growths of a malignant, cancerous nature are by our author believed to originate "in the embryonic bioplasm found in connection with complex structures," yet he also thinks that "the cause of the cancer development operates at a period of time separated by many, many years from the period of the actual production of the cancer-cells, * * * * * even during embryonic life." Is the last belief, which is warranted by the often observed cancerous diathesis, consistent with the former?

It is greatly to be regretted that Dr. Beale continues to use the word "bioplasm" for the living formative substance of organisms, called by all naturalists and known to a large portion of the public as protoplasm. It matters not if the word has been, as Dr. Beale states, used improperly, the fact remains that those who use the word protoplasm, use it in exactly the same sense in which Dr. Beale uses "bioplasm," and nothing but confusion can result from the introduction of a new term.

"Protoplasm" was first introduced to the English public in Von Mohl's work "On the Vegetable Cell," translated in 1851, and was known in Germany several years earlier. The existence of detached particles of living matter, destitute of a cell-wall, and usually smaller than cells, does not, whatever Dr. Beale may assert to the contrary, disprove the cell theory, which receives such continued confirmation from the work of microscopists in all parts of the civilized world, that it ought not to be called a theory, but a fact.

Cells are the bricks of which the Metazoan edifice is constructed, but that edifice is also the manufactory for their construction, and the laboratory for their destruction and the working up again of a great portion of their material.

What wonder is it, therefore, that in the fluids, and on and in the tissues should be found protoplasm, which has not yet been formed into cells, or which has previously existed in that state?

The formative powers of protoplasm, and the distinction varying greatly in its width, between the formative and the formed material, are recognized by all biologists, and it is difficult to see what addition Dr. Beale brings to our previous knowledge.

Dr. Beale, in common with all other biologists, finds that a certain complex physical substance, occurring only in the organic world, possesses properties and performs movements not possessed or performed by other kinds of matter. In common with all other biologists, he is in the most absolute ignorance of the cause of these movements, but, instead of confessing that ignorance, he asserts that they can only be accounted for by assuming the existence of "some sort of supra-physical or vital power." The latter term is admissible as a title for what we cannot explain, but the former term involves an assumption unwarranted by anything within the range of our knowledge. The belief that every unexplained fact is "supra-physical" belongs to the mediæval stage

of thought, and it is high time that it were banished from the beliefs and writings, as it is from the life and practice of the civilized portion of humanity.

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GENERAL NOTES.

BOTANY.[1]

THE QUILLWORTS OF NORTH AMERICA.—Probably few of the readers of the NATURALIST have given much time to the study of the grass-like or rush-like plants commonly designated as the quillworts, and included in the genus Isoëtes. They are Pteridophytes, that is, they belong to the great group of plants lying next below the Phanerogams, and distinguishable from the still lower plants by the possession of fibro-vascular bundles in their stems and leaves. The equisetums, ferns, adder-tongues, and ground-pines are among their relatives, and of these, the last named have by far the closest relationship. Although the plant-body of quillworts is much simpler than that of ground-pines and ferns, their reproductive organs are of a higher order, and for this reason they are to be regarded as among the highest of the Pteridophytes. In fact, in some respects, as for example in the germination of the microspores, there is an evident relationship to the Gymnosperms. The one, two or three small cells observable in the pollen grains of conifers are but little different from and are clearly homologous with the rudimentary prothallium of the quillworts.

The natural interest these plants possess, on account of their position so near the boundary line separating Pteridophytes from the lower Phanerogams, will be greatly enhanced by the excellent work recently done by Dr. Engelmann, the results of which have just been published in the Transactions of the St. Louis Academy of Sciences under the caption of "The Genus Isoëtes in North America," and also separately issued as a pamphlet of thirty-four pages. With his usual thoroughness the author has left little more to be desired in this admirable monograph. The history of the species, both as to discovery and publication is given with great fullness. From this we learn that "the first notice which we have of an Isoëtes in North America is given in Pursh's Flora" (A. D. 1806). During the succeeding quarter of a century but few specimens were collected. From 1831, when Robbins gathered *Isoëtes riparia* near Uxbridge, Mass., to the present time there has been a steadily increasing attention given to the species by collectors.

The morphological and biological characters are well worked out

[1]Edited by PROF. C. E. BESSEY, Ames, Iowa.

in sections 2 and 3 of the paper. In this part one regrets the absence of plates, which we hope the author may yet be enabled to add.

The whole number of species in the world is stated to be "perhaps forty to sixty," of which fourteen, besides a dozen well-marked varieties, occur in North America. It may be of interest to enumerate those occuring in this country, giving the geographical range, as indicated by specimens.

1. *I. lacustris* Linn.; Northern N. Y. to Lake Superior.
   var. *paupercula* Engelm.; Ry. Mts and California.
2. *I. pygmaea* Engelm; Californian Mts.
3. *I. Tuckermani* A. Braun; New England.
4. *I. echinospora* Durieu, *var. Braunii* Engelm.; Penn. northward and northwestward and to Utah.
   vars. *robusta* Engelm., *Bootii* Engelm., and *muricata* Engelm.; New England.
5. *I. Bolanderi* Engelm.; Cal., Oregon and Ry. Mts.
6. *I. saccharata* Engelm.; Maryland.
7. *I. riparia* Engelm.; Penn. to New England.
8. *I. melanospora* Englem.; Georgia.
9. *I. Engelmanni* A. Braun; Del. to New England to Missouri.
   var. *gracilis* Engelm.; Penn. to New England.
   var. *valida* Engelm.; Penn.
   var. *georgiana* Engelm.; Georgia.
10. *I. Howellii* Engelm.; Oregon.
11. *I. flaccida* Shuttleworth; Florida.
   vars. *rigida* Engelm. and *Chapmani* Engelm.; Florida.
12. *I. melanapoda* J. Gay; Ill. and Iowa to Indian Territory.
   var. *pallida* Engelm.; Texas.
13. *I. Butleri* Engelm.; Indian Territory.
   var. *immaculata* Engelm.; Tennessee.
14. *I. Nuttallii* A. Braun; Western Idaho to Oregon.

MODERN BOTANY AND MR. DARWIN.—In no one thing is the botany of to-day more sharply in contrast with that of a quarter of a century ago than in the attention now given to the study of plants *as living things*. The plant as a body of a certain form, occupying a definite amount of space, does not now absorb the whole attention of the botanist. For the botanist of to-day, plants are living, moving, feeling beings, whose habits and movements, and the secrets of whose lives are deemed worthy of the closest scrutiny and observation. In this work, the proper work of modern botany, Mr. Darwin led, and where he did not enter himself, he pointed out the way. The titles of his books alone, almost outline the whole work of the student of plant life. The "Contrivances by which Orchids are fertilized by Insects;" the "Movements and Habits of Climbing Plants;" the "Variation of Animals and Plants under Domestication;" the "Insectivorous Plants;" the "Effects of Cross and Self-fertilization;" the "Different forms of Flowers on Plants of the same Species;" the "Power of Movements in Plants;" certainly the field was well mapped out. Every book as it appeared gave a new impetus to biological botany, and at once directed attention to what in many cases had been almost entirely neglected subjects. It is, however, not so much what Mr. Darwin saw that others had not seen, for his

actual discoveries in botany are not many, as the rare power he possessed of making everything have a meaning. He added many fold to the pleasures of study by teaching us how to look in a new direction for the reasons for things. The colors, odors, forms, the irregularities of flowers are no longer but so many variations for tickling *our* sense organs. It may be a humiliating lesson to learn, but close observation compels us to acknowledge that the fine colors and forms, and the sweet odors have no necessary relation to us, and that had man never come into existence, they would still have been just as beautiful and just as fragrant as they are now.

In the domain of systematic botany, the great law of the modification of species is slowly (as was to be expected, Mr. Darwin not being a systematist) bringing about a complete revision of classification. Cohn's, Sachs', Caruel's, De Bary's and Gobi's recent systems are all attempts to bring out the genetic relationship of the various groups, which are considered to have descended from more primitive forms. The parasites and saprophytes need no longer be placed by themselves in a group of exceptional plants, but find their proper places as the degraded members of various groups of chlorophyll bearing plants. Once granted the origin of species by means of natural selection, and its full import understood and acknowledged, a mutual relation is seen to exist between one group and another, a relation which is much more than that of mere structural similarity. Under the influence of the Darwinian method, the vegetable kingdom is assuming a shape in our classifications, which shows a gradually increasing complexity, a gradual modification and differentiation as we pass from the slime molds to the flowering plants. The flower of the phanerogam is not wholly phanerogamic, it had its beginnings away down among the simple pond-scums, and is but the last link in a chain extending throughout almost the whole plant world.

Botanical Notes.—We see it announced that Williams & Norgate, of London, are to issue a work by Dr. M. C. Cooke, entitled "British Fresh Water Algæ, exclusive of Desmideæ and Diatomaceæ."——Parrish Brothers, of San Bernardino, California, offer sets of the plants of Southern California. The specimens are beautifully prepared, and are well worthy of finding place in any herbarium.——The first fascicle of "N. A. Gramineæ," under preparation by F. Lamson Scribner, of Girard College, Philadelphia, is to be issued soon. Collectors of the Gramineæ can aid the prosecution of this work by addressing the author as above. ——The manual of North American Lichens, recently published by S. E. Cassino, of Boston, has unfortunately not been stereotyped, which is much to be regretted, as the edition will, as a consequence, soon be out of print.——M. S. Bebb, in the March *Bo-*

tanical Gazette, concludes that the Californian willow, *Salix Coulteri* Anders. is "nearly allied to—if not identical with"—*S. sitchensis* Sanson, which, like *S. Coulteri*, he now finds to have but *one stamen under each scale!* *S. Coulteri* he regards as probably nothing more than "an extravagant autumnal growth of *S. sitchensis*."——In the same journal Dr. Farlow notices the injury to the vine in Europe and Algiers caused by the American grape mildew (*Peronospora viticola* B. & C.). In moist regions it appears to be very injurious, even approaching the *Phylloxera* in some cases. Lime, antiseptic fluids, and other applications, failed to check the parasitic growths. Burning the leaves to destroy the oöspores is recommended.——Dr. R. E. Kunzé's paper on "The Germination and Vitality of Seeds," read before the Torrey Botanical Club, contains a mass of valuable information collected from many sources. Copies may be obtained of N. L. Britton, School of Mines, New York city, for fifty cents each.——Among the valuable foreign botanical journals, which American students may profitably consult, the *Archives Botaniques du Nord de la France*, must be mentioned. Lotar's memoir on the comparative anatomy of the vegetative organs of the Cucurbitaceæ is well worth careful reading.——Dr. W. P. Wilson has published a paper on "The Cause of the Excretion of Water on the Surface of Nectaries," in which he shows it to be due not to internal pressure, as has generally been assumed, but to osmotic action. ——Dr. W. A. Kellerman's paper, *Entwickelungsgeschichte der Blüthe von Gunnera chilensis Lam.*, is a valuable contribution to our knowledge of these curious plants. Four plates accompany the paper.

ZOÖLOGY.

THE NATURE OF LIFE.—This is a tempting problem; it has attracted the attention of the thoughtful of the past, and is attracting the attention of the thoughtful of the present, yet in spite of untiring efforts, in spite of ingenious arguments, it is still unsolved. Is it insolvable? This again is a question not to be answered hastily, either in the negative or the affirmative, since so much that was once thought insolvable has been solved; while so much that was supposed to be solved (by revelation or authority) has proved to be still unknown. As indices which *may* point towards a solution, we give a short abstract of three papers that have lately appeared.

D. Monnier and C. Vogt (*Comptes Rendus*, Jan. 12, 1882) state that by the joint action of two salts forming by double decomposition one or two insoluble salts, are produced cellules, tubes and other forms assumed by organic life. The liquid in which this takes place may be of organic or semi-organic nature, or absolutely inorganic, but one of the salts must be dissolved in the liquid, while the other is present in a solid form. Saccharate of

lime and silicate of soda are among the liquids in which these pseudo-organic forms can be produced; certain viscid liquids yield no such results; the form of pseudo-organic product is constant with the same salts; and with some exceptions, the forms are only obtained from substances which are found in real organisms. Sulphates and phosphates produce tubes, carbonates give rise to cellules. Membraneous cell-wall, giving passage only to liquids; and heterogenous granular contents combine to render the resemblance to forms organically produced, most striking. M. Fournier obtained similar results as early as 1878.

Messrs. O. Loew and T. Bokorny, of Munich, have worked the idea advanced by Professor Pflüger, that there is a chemical distinction between living and dead protoplasm, up to a tangible hypothesis. Herr Loew found that albumen contained a number of aldehyde-groups closely bordering on amide-groups. Such groups, according to modern chemistry, must have intense atomic motion, and Herr Loew argued that this motion constitutes life. It was found that living protoplasm had the power of reducing silver from a very dilute alkaline solution, whilst dead protoplasm lacked this power. Their theory is that the aldehyde-groups of each molecule are brought into immediate proximity with the amide-groups of the next, thus causing intensification of molecular action; with increased complexity and mobility follows increased instability, and thus apparently trifling agencies displace the molecules, cause their action to cease, and liberate heat, producing fevers, etc. When lifeless albumen is converted into the protoplasm of a living cell, heat becomes latent. Vital force, in the opinion of these chemists, is due to the tension of the aldehyde-groups ultimately due to electric differences, and life is the total result yielded.

The reviewer in the *Journal of Science* points out that Loew and Bokorny appear to regard albumen and protoplasm as identical, whereas, according to the analyses of Reinke, protoplasm contains scarcely thirty per cent. of albuminous matter, and includes upwards of forty proximate principles. The third contribution to the subject is that of O. Bütschli, who in *Zoologischer Anzeiger* publishes some original thoughts of life and death. He first draws attention to the great difference between the nature of death in the Protozoa and Metazoa. In the former the parent never exists by the side of its offspring, its reproduction (by fission or spore-formation is the death of the individual. The higher animals, on the other hand, live after the birth of their offspring, but for a certain limited time, and their death throws a quantity of organic matter into inactivity. He then finds the hypothetical cause of the limited duration of individual life in the nature of the egg, which he supposes to endow the individual with a limited quantity of a "in a certain sense ferment-like working substance" *(in gewissem Sinne fermentartig wirkenden Stoffes).* This limited

quantity diminishes perpetually in energy, and is finally exhausted, producing the death of the individual. Meanwhile, certain tracts are set aside as reproductive organs, and produce a fresh supply of this "life-ferment" for the continuance of the species. The rejuvenescence of the nucleus of the infusoria by conjugation is homologized with that of the egg by the spermatozoa, but while the nucleoli of the infusoria are principally concerned in the process of rejuvenescence, the cells which bring about development in the metazoa proceed chiefly from the nucleus of the male sexual cells.

This is at least an ingenious hypothesis, but lacks support from observation. We know of no "life-ferment," and protoplasm the only life-substance we know of is certainly produced in plants, while animals contain more than they derived from the egg.

Is Man the Highest Animal?[1]—The measure of zoölogical rank is the specialization exhibited by all the organs, taken collectively. Specialization may be exaggerated in one or several organs, without the animal therefore attaining as a whole a high rank. This is the case in man. The measure of specialization is afforded by embryology, which shows in earlier stages the simplicity and uniformity of structure, which in later stages is replaced by complexity. The human body preserves several important embryonic features. In man we find three series of high differentiations, namely: in the brain, in the changes induced by or accompanying the upright position, and third in the opposibility of the thumbs to the other digits. These are the principal, though of course not strictly the only characteristics of man, which show that he is more specialized than any other animal. In other respects he shows a still more striking inferiority. It is of course a familiar observation that his senses are less acute than those of many animals—he has neither the keen vision of the falcon, nor the delicate scent of the dog. He is equally inferior in many structural features. His teeth are of a low mammalian type, as is shown both by his dental formula, and by the presence of cusps upon the crowns of the teeth, a peculiarity of the lower mammalia, entirely lost in the horse, the elephant, and many other "brutes." His limbs show a similar inferiority since they are little modified, preserving even the full number of five digits, and in respect of these members man stands therefore very low, lower than the cow and the pig. He plants the whole sole of his foot upon the ground, yet none except the lower mammalia, together with man and his immediate congeners are plantigrade. So too with his stomach, which is so simple as compared with that of a ruminant, and indeed is of about the same grade as that of the carnivora. It makes, however, a still more forcible impression to

[1] Read before the American Association for the Advancement of Science, Cincinnati meeting, August, 1881.

learn that the human face, which we admire when withdrawn under a high intellectual forehead, is perhaps the most remarkable of all the indices that point out man's inferiority. In the mammalian embryo the face is formed under the fore brain or cerebral hemispheres. In our faces the fœtal disposition is permanently retained, with changes, which when greatest are still inconsiderable. In quadrupeds the facial region acquires a prominent development leading to the specialization of the jaws and surrounding parts, which brings the face to a condition much higher than that of the fœtus. Hence the projecting snout is a higher structure than the retreating human face. These facts have long been familiar to anatomists, but I am not aware that the inferiority of the human to the brute countenance has heretofore been considered a scientific conclusion by any one. Yet that inferiority is incontrovertible and almost self-evident.

The preceding statements render it clear to the reason, that man is not in all respects the highest animal—and that it is a prejudice of ignorance, that assumes that the specialization of the brain marks man as above all animals in the zoölogical system. It does give him a supremacy by his greater power of self-maintenance in the struggle of the world, but that has nothing whatsoever to do with his morphological rank. There is nothing in morphology that anywise justifies assigning, as is actually done, an almost infinitely greater systematic value to the specialization of the brain and a specialization of the limbs, stomach, teeth, face, etc., hence it is impossible to call man even the highest mammal. It is also doubtful whether mammals would be regarded as the highest class of the animal kingdom, were they not our nearest relatives. Let us beware of claiming to be the head of organic creation, since the Carnivora and Ungulata are in many respects higher than we. I believe that it is just as unscientific to call any one animal species the highest, as to pitch upon any one plant to stand at the head of the vegetable kingdom.—*C. S. Minot.*

Zoological Notes.—Mr. Chas. Linden, in a paper in the Bulletin of the Buffalo Society of Natural Sciences, states that the wood duck is easily domesticated, Mr. Irvin having raised successive broods of that species for many years, amounting frequently to thirty or more full-fledged young in one season. All the various ducks he experimented with migrated southward each autumn, and infallibly returned with a male mate, which remained until the young began to hatch. The observations recorded indicate that the majority of our wild ducks do not easily change their wild condition, but yet manifest no aversion to breeding freely when placed under artificial restraint.——Mr. Fewkes has described in the *American Journal of Science* for February, a Cercaria $\frac{1}{16}$ inch long, found swimming with a jerky motion by means of a long tail, which at intervals has bundles of long setæ arranged on opposite sides like those of an annelid. Mr. Fewkes in stating that in the possession

of regular paired bundles of bristles, this Cercaria differs from all others known, has apparently overlooked the work of Valette St. George, wherein he figures *Cercaria setifera* Müll. and *C. elegans* Müll., both inhabiting the Mediterranean sea. The tails are provided with bundles of setæ in pairs, and are much as in Mr. Fewkes species.——In his tenth census report on the Oyster Fishery, Mr. E. Ingersoll describes the way in which the star-fish gains entrance to the oyster shell in order to feed upon it. Having met with an oyster, scallop, or other thin-shelled mollusk, and young ones are preferred because their armor is weak, the star-fish folds his five arms about it in a firm and deadly grasp. Then protruding the muscular ring at the entrance of his stomach through the circular opening in the centre of the under side of the disc, which he previously describes, he seizes the thin, newly-grown posterior edge of the shell, which oystermen call the "nib" or "bill," and little by little breaks it off. Then the star-fish protrudes into the shell the distensible mouth of the stomach, until it can seize upon the body of the mollusk. "The consumption of this begins at once, and as fast as the poor oyster's or scallop's body is drawn within its folds, the capacious stomach is pushed farther and farther in, until at last if the mollusk be a large one, the pouches that I have described as packed away in the cavities of the ray, are also drawn forth, and the starfish has substantially turned himself wrong side out. If he is dredged up at this stage as many examples constantly happen to be, and dragged away from his half-eaten prey, his stomach will be found hanging out of the centre of his body for a distance, perhaps, equal to half the length of one of the arms, and filled with the juices of the oyster he has devoured, and whose body, within the shell, will be found almost as squarely trimmed as could have been done by scissors." The wholesale manner in which the star-fish invades oyster beds, and the great increase in numbers of this creature since oyster beds have been planted are described. The injury done to oyster beds by the star-fish from Buzzard's bay to the western end of Long Island sound is estimated at $200,000 a year.

ENTOMOLOGY.[1]

NOTES FROM ILLINOIS; GRAIN-FEEDING HABITS OF FIELD CRICKET.—One morning after a rainy night, as I was passing along the highway, I noticed one of our common field crickets working at a kernel of corn that had dropped from some farmer's wagon while on the way to market. The rain had softened the grain; and after watching the insect some time, I found it was eating the germ of the softened kernel; I watched patiently until the cricket seemed to have satisfied its hunger, and found the germ had all

[1] This department is edited by PROF. C. V. RILEY, Washington, D. C., to whom communications, books for notice, etc., should be sent.

been eaten away. Early in the fall I found them in cornfields eating the crowns of kernels or ears that had blown to the ground, something I had always before attributed to mice.

The same insect has annoyed farmers considerably in another manner. Much of the harvesting is done with self-binding harvesting machines, using cord for binding. Judge of the surprise and chagrin of the farmer when on drawing in his stacks of grain, to find instead of compact bound sheaves only a mass of unbound grain, the bands of cord having been cut in many places by the crickets. Also I noticed numbers of our common black blister-beetle *(Epicauta pennsylvanica)* denuding the ears of corn of the silk before the kernel had been fecundated, thereby either partially or wholly destroying the ear. I have also found *Diabrotica fossata* Lec., which usually feeds upon the pollen of the flowers of the Compositæ, varying its bill of fare by eating the pollen of corn. Its near relative, *D. longicornis* Say, which I fear is to be the future pest of the cornfield, I found feeding upon both silk and kernel; one individual had excavated nearly the whole interior of a kernel, and was still at work, being so far advanced into the interior as to leave only the tip of its abdomen visible. I had supposed the insect relied upon the flowers of thistle and some of the Compositæ for its food, but now think were all of these taken away it would find abundant sustenance in the cornfield itself.—*F. M. Webster, Waterman, Ills.*

Habits of Cybocephalus.—There is nothing recorded, to our knowledge, concerning the habits of this little Nitidulid genus, distinguished by its peculiar appearance from the allied genera. In the summer of 1881 we received from Dr. J. H. Mellichamp of Bluffton, S. C., several twigs of *Pinus elliottii*, the leaves of which were covered with a Coccid, *Chionaspis pinifoliæ* Fitch. We kept these twigs in a jar in the hope of obtaining Chalcid parasites from the scales and were rewarded by the appearance of several specimens of *Cybocephalus nigritulus* Lec. We had then every reason to suspect that this little beetle, either as larva, or imago, or in both stages, was feeding upon the scales. Our presumption has been lately corroborated by receiving numerous specimens of *C. californicus* Horn, sent by Mrs. A. E. Bush from San Jose, California, with the remark that they were found on an apple twig badly infested by a scale insect.

One Effect of the Mississippi Floods.—Few evils are without their compensating benefit. The planters of the Teche country will, in all probability, be free for a number of years from the attacks of a beetle *(Ligyrus rugiceps)* which has of late years proved very destructive to the sugar cane there. It will undoubtedly have been drowned out by the months of submersion which the fields of the infested region have suffered. Late reports indicate that even the stubble has become spoiled, and that little, if

any, seed cane will be saved the present year. This will necessitate an importation of seed on a large scale, and we shall be agreeably surprised if the accompanying importation of some new insect foe to the sugar cane is not chronicled within a very few years.

DORYPHORA 10-LINEATA IN ENGLAND.—Mr. J. Jenner Weir, a member of the London Entomological Society, found early last spring a living specimen of *Doryphora 10-lineata* which had been taken to London from this country in a barrel of potatoes.

DR. DIMMOCK'S INAUGURAL DISSERTATION.—We sincerely congratulate Dr. Geo. Dimmock, of Cambridge, Mass., on the successful completion of his dissertation on "The anatomy of the mouth-parts and of the sucking apparatus of some Diptera," by which he lately obtained the degree of Ph.D. at Leipzig University. It is an important contribution to our knowledge of comparative anatomy, and fully justifies us in expecting most valuable work from its author in this direction in the future. Mr. Scudder's remarks at the Boston meeting of the American Association for the Advancement of Science, upon the field offered by insect anatomy and physiology cannot be too heartily endorsed, and we consider Dr. Dimmock's paper a forerunner of much excellent work by American students in the near future.

THE TRIUNGULIN OF MELOIDÆ.—"Nothing new under the sun!" From a recent letter received from our friend M. Jules Lichtenstein, of Montpellier, we learn that the old entomological writer Johann Leonhard Frisch in his remarkable work "Beschreibung von allerley Insecten in Teutschland, etc.," tome VI., published in 1727, was well acquainted with and describes, p. 15, the triungulin of *Meloë proscarabæus;* while some sixty years later Réaumur, DeGeer, and other old entomological writers did not know what the triungulin was. Frisch was also familiar with the male of the Coccidæ.

FOSSIL TINEIDS.—Mr. V. T. Chambers communicates to *Nature* (Vol. 25, p. 529) as corroborative of the Tineid nature of certain serpentine, thread-like trails found by Lesquereux on leaves of magnolia from the Tertiary of Alaska, that he distinctly remembers seeing the figure by the same author of a fossil leaf of *Acer* on which there were several blotches, one of which bore a strong resemblance to the mine of *Lithocolletis aceriella*, now made in leaves of *Acer saccharinum.*

CLASSIFICATION OF NORTH AMERICAN COLEOPTERA.—We are glad to learn that the new edition of the classification of North American Coleoptera to be published by the Smithsonian Institution, is being rapidly pushed to completion by Messrs. LeConte and Horn. The first edition was never completed and is now out of print, but it did more to promote Coleopterology in the United

States than any other work published either before or since. It has become somewhat antiquated, however, and it is gratifying to know that we shall soon have a new edition brought up to date and written by the two men most competent to do the work.

EXCHANGES WITH SOUTH FRANCE.—M. Franz Richter, assistant to M. Lichtenstein, at Montpellier, offers all objects of natural history in the south of France, and more especially southern *Hymenoptera* well-named, Aphididæ and Coccidæ in microscopic preparations. He has also sets of *Phylloxera* in the various life-stages.

HIBERNATION OF THE ARMY WORM.—The experience of the past winter has very fully confirmed the revised conclusions we reached in 1880 respecting the hibernation of *Leucania unipuncta* in the larva state. We found the larvæ of all sizes throughout the milder winter weather in Washington, and the first moths issued from them early in March or about the time when in South Georgia what may safely be assumed to have been a second generation of worms for that latitude were found of all sizes. At the present writing, in Washington the second generation of moths are ovipositing, preferring, in the open field, as we rightly inferred in 1877, old hay and stubble and coarse grass or corn stalks to the green grass, whenever the former are at hand. From the widespread occurrence of this insect wherever we have sought it so far, we conclude that much damage will result from the second and third broods of worms in the more northern States.—*C. V. Riley, May 4, 1882.*

ANTHROPOLOGY.[1]

DR. RAU'S LATEST CONTRIBUTION TO ANTHROPOLOGY.—The Smithsonian Institution has done a very important service to archæology by collecting into a single volume all the papers of Dr. Rau published in the Smithsonian Annual Reports. The work includes the following monographs:

Baegert's account of the aboriginal inhabitants of the Californian peninsula (Reports 1863 and 1864).
Agricultural Implements of the North American stone period (1863).
Artificial shell deposits in New Jersey (1864).
Indian Pottery (1866).
Drilling in stone without metal (1868).
A deposit of flint implements in So. Illinois (1868).
Memoir of C. F. P. von Martius (1869).
Ancient aboriginal trade in North America (1872).
North American Stone Implements (1872).
The prehistoric antiquities of Hungary (1876).
The stock-in-trade of an aboriginal lapidary (1877).
Observations on a gold ornament from a mound in Florida (1877).

Inasmuch as these articles were reprinted from stereotype

[1] Edited by Professor OTIS T. MASON, 1305 Q. street, N. W., Washington, D. C.

plates, the author has called attention to additional information, or a modification of his views in a preface of six pages.

Every young archæologist should possess and study this work, and older investigators will receive no harm from reviewing with Doctor Rau the grounds of their faith.

THE BOOKS OF CHILAN BALAM.—A pamphlet bearing the foregoing title is issued by Edward Stern & Co., of Philadelphia. It is the substance of an address by Dr. Daniel G. Brinton to the Numismatic and Antiquarian Society of Philadelphia, in January last, which appeared also in the *Penn Monthly* for March. The Mayas of Yucatan possessed a literature written in "letters and characters," preserved in volumes neatly bound, the paper manufactured from the bark of a tree and sized with a durable white varnish.

The old sacred rituals preserved in these volumes were ruthlessly destroyed, but some of the intelligent natives, instructed in Spanish, wrote out in a new alphabet, partly in that language and partly in their own, what they remembered of the contents of their ancient records.

In whatever village or by whatever hand written out, each of these books was and is called "The Book of Chilan Balam." In the pamphlet before us, Dr. Brinton gives a digest of this wonderful work, together with photolithographs of the signs of the months compared with those of Bishop Landa.

THE RELATION OF HISTORY TO ANTHROPOLOGY.—In no way is the influence of anthropologic methods better exhibited than in the changes which have taken place among historians as to their manner of treating their subject. The best illustration of this we have seen is the History of Ancient Egypt, by Canon George Rawlinson, published in two beautifully illustrated volumes by S. E. Cassino, of Boston. The Egyptians themselves, undesignedly, realized that in the coming centuries there would arrive a time when men would tire of reading about long lists of kings and of royal personages, and would ask how did such a people dress, eat, build, work, fight, amuse themselves? How did they organize their society? How did they treat each other, their women, children, friends, or rulers? What were their methods, customs, and ceremonies? What did they know, and how did they use their knowledge? They perpetuated the knowledge of all these things in hieroglyphics on papyrus and cut in stone. Their climate favored the permanence of their record. Canon Rawlinson has written history before. His works on the great monarchies of the east supersede the older histories. For a long time the work before us will be the student's guide book to the geography, climate, races, language, industries, art, science, and religion of the land bordering the river which, "issuing from the equatorial regions, has strength to penetrate the 'frightful desert of interm-

inable scorching sand,' and to bring its waters safely through two thousand miles of arid, thirsty plain, in order to mingle them with the blue waves of the Mediterranean."

DARWIN AND ANTHROPOLOGY.—When weeping friends gather to pay their last respects over the grave of a great pilot, the reigning thought in the minds of those who had sailed with him in former years would be the recollection of pleasant days and nights, narrow escapes, and almost miraculous deliverances. So perfectly human would be this oneness with the dead that for a time the gallant ship, the faithful sailors, and the helpful passengers would be quite forgotten, or else all their good qualities would be merged and blended with the virtues of this one heroic soul.

In attempting to study the connections of Charles Darwin with the natural history of man, we are embarrassed by this same feeling. We realize that in twenty-three years we have come a great journey, we have passed by innumerable shoals and quicksands, we have made decided progress in the right direction. How much of this work was done by Mr. Darwin? How much did he immediately inspire? How much was accomplished by those who had drank of his inspiration? How much was the logical fruit of seed which he had sown? How much was the outcome of opposition to him? In the brief space allowed to this note of regret, discussion of these topics would be impossible. Suffice it to say, there is no one acquainted with the progress of anthropology who will not admit that a great part of our latest anthropological research has been carried on through one of the motives enumerated above.

No doubt, in archæology, in anthropo-biology, in the elaboration of industries or comparative technology, it was known before Mr. Darwin's day that there had been evolution, selection, survival of the fittest. The great merit of Mr. Darwin's work and influence in anthropology had been the application of the same rule to anthropogeny, archæology, biology of man, evolution of races, of mentality, of language, of arts, of society, of philosophy, of creed, of cult, and of the amelioration of the race through better knowledge of and better adaptation to the environment, taking the word in its widest acceptation.

Although the greater part of Mr. Darwin's influence upon anthropology has been indirectly exerted, his own personal contributions were of no mean order. Long before he had publicly made the application of the doctrine of descent to include the human race, his disciples had boldly affirmed that man, so far as his body is concerned, is no exception to the great law of the consanguinity of all living creatures. The publication of the Descent of Man and the work on the expression of emotions convinced all readers, however, that the man with a thousand eyes had been

gathering materials for another great induction. Not content with the guesswork of his pupils, he determined to submit his own theories to the most rigid scrutiny.

ANTHROPOLOGY IN GERMANY.—The *Archiv für Anthropologie*, issues a supplement to its thirteeth volume, which contains the following contributions:—

Hölder, H. v.—The skeletons in the Roman cemetery in Regensburg. pp. 1–52.

Schmidt, Emil—The import of cranial capacity. pp. 53–80.

Reviews:—Scandinavian Literature, by Miss J. Mestorf, including Engelhard, Sophus Müller, Steenstrup, Nicolaysen, Rygh, Udset Ingvald, Hildebrandt vonWaldheim, Montelius Söderwall;—by Dr. Fligier, including Diffenbach, Oppert, Spamer, Peschel;—by Schaafhausen, of the ninth International Congress for Prehistoric Anthropology and Archæology in Lisbon from 20–29 September, 1880.

One hundred and twenty pages of the supplement are devoted to a Catalogue of Anthropological Literature, published mainly in 1880, containing.—

I. Archæology and priscan history, by J. H. Müller.

II. Anatomy, by A. Ecker.

III. Ethnography and Travels, by Dr. Fredrich Ratzel.

IV. Zoology in its relation to Anthropology, by Dr. W. Branco.

ANTHROPOLOGY IN GREAT BRITAIN.—Vol. XI., No. 3, of the Journal of the Anthropological Institute, is an exceptionally valuable contribution to knowledge, having very little of speculation and a great deal of important information. The following is a list of the papers:—

Woodthorpe, Lt.-Col. R. G.—Notes on Wild Tribes inhabiting the so-called Naga Hills, on the North-East Frontier of India.

Thane, George D.—On some Naga skulls.

Howorth, H. H.—The spread of the Slavs. Part IV.

Man, E. H.—On the Andamese and Nicobarese.

Thomson, Dr. Allen—Description of Andamanese Bone Necklaces.

Frere, The Right Hon. Sir. H. Bartle—On the laws affecting the Relations between Civilized and Savage Life, as bearing on the dealings of Colonists with Aboriginies.

Mr. Woodthorpe's paper is part II. of his studies, respecting the unkilted Nagas. The author minutely describes their physique, customs, clothing, habitations, burial, skull trophies, and ceremonies. Professor Thane describes the crania of the Nagas procured by Colonel Woodthorpe and others.

Mr. Howorth, as is well-known, has given years of his life to the Slavic races and in the communication just cited devotes his pen to the Bulgarians. "There is a political Bulgaria and an ethnographic Bulgaria." The two are different in boundaries and otherwise. The former includes all the country subject to the Bulgarian crown in the days of its greatest prosperity, the latter includes the area peopled by Bulgarians properly so-called.

Mr. Man was not only an eye-witness of what he has recorded,

but he is a keen observer, and a piquant writer. He has a charming way of knocking over old conceptions of how things must have been. For instance, the bamboo gridiron becomes a drying-grate; boiling meat in a bamboo pot over the fire is changed to roasting the whole affair, pot and all; holes in the ground to sleep in, are nothing but children playing burial, etc. For comparative technology, the article is invaluable. The necklaces described by Dr. Thomson are made from human bones.

Sir. Bartle Frere's paper, however, is the one of greatest moment. The editor of these notes read a paper on the same topic at the American Association last summer. Sir. Bartle Frere's observations were made in India, where the Aryan peoples have been in contact with uncivilized and more aboriginal races from the earliest times, and in South Africa among the Hottentots, Bushmen, and the Banta Tribes.

GEOLOGY AND PALÆONTOLOGY.

THE ANCESTRY AND HABITS OF THYLACOLEO.—The recent reception of nearly complete specimens of the mandibles of the *Ptilodus mediævus* (NATURALIST, November, 1881), enables me to correct the table of genera of *Plagiaulacidæ*, given in the May, 1882, NATURALIST. The remarkable mammal in question turns out to have but one huge cutting premolar tooth, and to present considerable resemblance to the supposed "pouched lion" (*Thylacoleo carnifex*) of the Australian Pliocene formation, which excited so much discussion a few years ago in England. Considerable light is thrown on the history of this group, which disappeared so early in Europe and America, to survive in Australia almost up to the present geological age.

The genera of the family differ as follows:

a. Several large cutting premolars.

Premolars four, sides not ridged..... *Ctenacodon.*

Premolars typically three, with oblique lateral ridges..... *Plagiaulax.*

aa. One large cutting premolar.

β. Inferior molars with several tubercles.

Large premolar without posterior cusp; edge directed upwards; sides ridged *Ptilodus.*

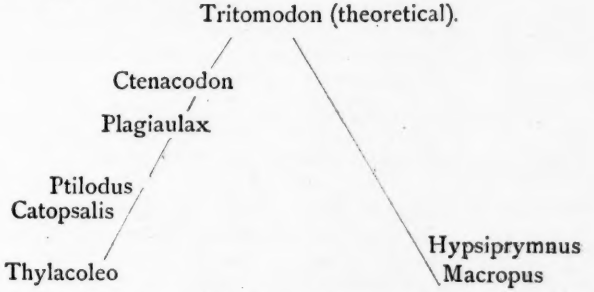
Large premolar with posterior cusp; edge directed forwards; sides (?) not ridged *Catopsalis.*

ββ. Inferior molars small with few lobes; the last rudimental.

Large premolar without posterior cusp; edge directed upwards; sides not ridged *Thylacoleo.*

The phylogeny of these forms, in connection with that of the kangaroos, may be expressed as follows: It is evident that such forms as *Thylacoleo*, *Ptilodus*, and *Catopsalis* are more specialized than *Plagiaulax* and *Ctenacodon*, inasmuch as the number of teeth is reduced, and the cutting function of the premolars is concentrated in a single large tooth. This is quite the same kind of specialization

as that which has taken place in the history of the descent of the Carnivora. *Ctenacodon*, as having the largest number of premolars, which have the least amount of sculpture, is the least specialized of all the genera. *Thylacoleo*, with the rudimental character of the true molar teeth, is the most specialized, as it is the latest in time. The *Macropodidæ* retain the full series of true molar teeth of the primitive Mammalia, and present only a cutting third premolar in the lower jaw, the fourth resembling the true molars. Thus the cutting tooth of *Thylacoleo* is not the homologue of the cutting tooth of *Hypsiprymnus* as supposed by Professor Flower,[1] since the latter corresponds with the cutting tooth of *Ptilodus*, which is the fourth premolar of *Plagiaulax*. We must therefore regard *Hypsiprymnus* as the descendent of a type from which the *Plagiaulacidæ* were also derived, in which some of the premolars, as far as the third only, were trenchant, and in which the fourth premolar possessed the tubercular character of the true molars. Such a type would belong to Jurassic and perhaps even to Triassic times, and might well have continued to the Eocene. I call it provisionally by the name *Tritomodon*. The lines of the descent will appear as follows:



The discussion between Professor Owen, on the one hand, and Messrs. Falconer, Krefft, and Flower, on the other, as to the nature of the food of *Thylacoleo*, is known to palæontologists. From the form of the teeth alone Professor Owen inferred the carnivorous nature of the food of this genus, while his opponents inferred a herbivorous diet from the resemblance between the dentition and that of the herbivorous *Hypsiprymnus*. As the result of the discussion affects, in some degree, the genera *Catopsalis* and *Ptilodus*, I recall it here. The comparison of *Thylacoleo* with *Hypsiprymnus* is weakened by two considerations: First, the fact that the cutting tooth of the former is not homologous with the cutting tooth of the latter; and second, that the grinding series of molars of the former is rudimental, while in the latter it is complete. It evidently does not follow that because *Hypsiprym-*

[1] Quarterly Journal Geological Society, 1868, Vol. XXIV, p. 307.

nus is herbivorous, *Thylacoleo* is so also. Professor Flower refers to the reduction of the molars in *Thylacoleo* as slightly complicating the problem, and concludes that the food of that animal may have been fruit or juicy roots, or even meat. It is difficult to imagine what kind of vegetable food could have been appropriated by such a dentition as that of *Ptilodus* and *Thylacoleo*. The sharp thin, serrate, or smooth edges, are adapted for making cuts and dividing food into pieces. That these pieces were swallowed whole, is indicated by the small size and weak structure of the molar teeth, which are not adapted for crushing or grinding. It is not necessary to suppose that the dentition was used on the same kind of food in the large and the small species. In *Ptilodus mediævus* the diet may have consisted of small eggs, which were picked up by the incisors and cut by the fourth premolar. In *Thylacoleo* it might have been larger eggs, as those of the crocodiles, or perhaps carrion, or even the weaker living animals. The objection to the supposition that the food consisted of vegetables, is found in the necessity of swallowing the pieces without mastication. In case it could have been of a vegetable character the peculiar premolar teeth would cut off pieces of fruits and other soft parts as suggested by Professor Flower, but that these genera could have been herbivorous in the manner of the existing kangaroos with their full series of molars in both jaws, is clearly inadmissable.—*E. D. Cope.*

Notes on Eocene Mammalia.—The creodont, *Lipodectres penetrans*, turns out to be identical with the *Deltatherium fundaminis*. *Deltatherium absarokæ* must be referred to a new genus with the dental formula I. $\frac{2}{3}$; C. $\frac{1}{1}$; P–M. $\frac{3}{4}$; M. $\frac{3}{3}$. The premolars in *Deltatherium* are $\frac{3}{3}$, and in *Proviverra* $\frac{4}{4}$. The fourth superior premolar has an internal lobe, and a single trenchant external lobe, and the fourth inferior premolar is different from the first true molar. The genus may be called *Didelphodus*.

The *Oligotomus osbornianus* must be referred to a new genus. If it is not condylarthrous, it must be placed in the Chalicotheriidæ, as the most primitive form. The superior true molars have eight cusps, two internal, two intermediate, two principal external, and two external rising from the cingulum. The posterior of the latter is opposite the interval between the principal external, and if confluent with them would complete the two external V's of the other genera of the family. Inferior molars and last premolar, consisting of two V's. I call it *Ectocion*.——*E. D. Cope.*

On the Taxeopoda, a New Order of Mammalia.—A further examination of the carpus of *Phenacodus* shows that it is different from that of the order *Perissodactyla*, and agrees with that of the *Amblypoda*, *Proboscidea* and *Hyracoidea*. In the three groups last mentioned, the os magnum supports the lunare, and does not

articulate with the scaphoid, while in the *Perissodactyla* it sustains the scaphoid, while the lunar rests extensively on the unciform. As compared with the three groups named, *Phenacodus* stands intermediate between the *Amblypoda* and the *Proboscidea*, and agrees with the *Hyracoidea* in the slight posterior articulation of the unciform with the lunar bone. The peculiar carpus characteristic of the *Perissodactyla* is seen in the genera *Triplopus* and *Hyrachyus*, and in the older *Hyracotherium*, which is the cotemporary of *Phenacodus*. There seems to be no sufficient ground for separating the latter from the *Proboscidea* as a full order, so I combine the two groups in one, under the name of *Taxeopoda*.

The *Taxeopoda* is the primitive type of Ungulata in having the carpal and tarsal bones arranged in linear series. In the more specialized orders of *Perissodactyla* and *Artiodactyla*, the second series of these bones has been rotated inwards one place. The *Amblypoda* has the fore foot of the primitive type, and the hind foot of the more specialized type.

The group of *Ungulata*, whatever rank it may have, will then be divided into the following orders or sub-orders:

I. Os magnum supporting os lunare, and not articulating with os scaphoideum.

a. Astragalus articulating only with navicular.

Fibula with interlocking articulation with astragalus.....*Hyracoidea.*
Fibula with lateral contact only with astragalus.....*Taxeopoda.*

aa. Astragalus uniting with both navicular and cuboid.

Lunar uniting with unciform; fibula only in contact with astragalus....*Amblypoda.*

II. Os magnum supporting os scaphoideum; lunar supported in part by unciform. Astragalus uniting with both cuboid and navicular.

Astragalus truncate distally; median digit longest.....*Perissodactyla.*
Astragalus ginglymoid distally; two median digits equal.....*Artiodactyla.*

The *Taxeopoda* are naturally divided into two sub-orders, the Proboscidea and Condylarthra, as follows.

No postglenoid process, nor third trochanter of femur. Fibula articulating with a facet of the calcaneum.....*Proboscidea.*
A postglenoid process, and a third trochanter of the femur; no calcaneal facet for fibula.....*Condylarthra.*

It is probable that the *Toxodontia* form a third division of the *Taxeopoda*. It is also probable that the *Hyracoïdea* should be reduced to the position of a subdivision of the *Taxeopoda*—*E. D. Cope.*

Geological News.—In the *Geological Magazine* for March, Mr. A. S. Lucas discusses the age of the Headen Beds of the Isle of Wight, and M. J. E. Lee notes a peculiarity in the structure of a Pteraspidean plate found in the Eifel. This plate shows a repetition of the usually supposed outer corrugated layer, one of which is placed between two honey-comb layers, and an absence of the nacreous layer, thus throwing some doubt upon the received order of the occurrence of these layers. Mr. E. T. Newton gives a list of seventeen species of fishes, the remains of which have been

found in the Forest-bed series of the east of England.——At a recent meeting of the Geological Society of London, Professor Owen described *Notochelys costata*, an extinct Chelonian from Blinder's river, Queensland. It is the first known Australian fossil turtle, and is of a generalized type between the Chelydrians and marine turtles. At the next meeting of the same society (Feb. 8, 1882), Mr. J. W. Hulke described *Iguanodon Seelyi* from a bed between the clays and gravel of the cliff in Brook bay, Isle of Wight.——Various and prolific seams of anthracite and bituminous coal, some of them 10 ft. or 12 ft. in thickness, have been found in Natal.——Professor Marsh contributes to the *American Journal of Science*, an article upon the wings of Pterodactyles, with a full size plate of *Rhamphorhynchus phyllurus* Marsh. The specimen described was found in the lithographic states of Bavaria, and shows very perfect impressions of the volant membranes of both wings, as well as of a separate. vertical rudder at the end of the long tail. The membrane was similar to that of bats.——In the Journal of the Cincinnati Society of Nat. History, Mr. S. A. Miller describes some new species and genera of Palæozoic fossils. He also gives a well-merited criticism of Professor Nicholson's book on *Monticulipora*, showing the extensive ignorance of its author of American writings on the subject. We performed the same duty for the same writer's manual of Palæontology a year or two ago.

MINERALOGY.[1]

Two new Guano Minerals.—Professor C. U. Shepard[2] has described two new minerals which have originated in the guano formation covering the islands of Moneta and Mona, near Porto Rico, W. I., and to which he gives the names *Monetite* and *Monite*. They were found lining the walls of cavities in the rock guano, and, though undoubtedly formed through the action of percolating waters, contain no organic matter.

Monetite occurs in crystals having the form of rather thin rhomboids, often interpenetrating each other to form complex groups. Mr. E. S. Dana refers them to the triclinic system. Their greatest length is between $\frac{1}{12}$th and $\frac{1}{20}$th of an inch.

The mineral has an uneven fracture, a vitreous lustre, a pale, yellowish-white color, and is semi-transparent; hardness 3.5; specific gravity about 2.75. Heated before the blow-pipe in the forceps, it turns white and melts into a globule with crystalline facets.

It has the following composition (mean of two analyses by C. U. Shepard, Jr.):

Lime	Phosphoric acid	Sulphuric acid	Water.
40.255	47.100	4.550	8.175 = 100.080

[1] Edited by Professor Henry Carvill Lewis, Academy of Natural Sciences, Philadelphia, to whom communications, papers for review, etc., should be sent.

[2] American Journal Sciences and Arts, May, 1882, p. 400.

On subtracting the gypsum and hygroscopic water, and raising the percentage to 100, there was obtained:—

P_2O_5	CaO	H_2O
52.28	41.14	6.58 = 100

giving the formula $2CaO, H_2O, P_2O_5$. It is associated with crystallized gypsum and calcite, and with the following species.

Monite is massive, slightly coherent, and wholly uncrystalline. It is snow-white, earthy and dull, with hardness below 2, and specific gravity about 2.1. In the closed tube it emits much moisture, and in the blow-pipe flame melts with difficulty to an opaque white enamel.

A mean of analyses, after deducting an admixture of gypsum, gave

P_2O_5	CaO	H_2O
41.92	51.15	6.93

corresponding to $Ca_3P_2O_8+H_2O$.

It resembles kaolinite, and is a hydrated tricalcic phosphate.

URANOTHALLITE.—Schrauf[1] has named the variety of Liebigite from Joachimsthal, analyzed long ago by Vogl and Lindacker, *Uranothallite*. It contains more lime than Liebigite, and its composition may be represented by the formula $Ca_2UC_4O_{12}$ +10 aq. It occurs in minute aggregated crystals and grains, often scaly, and has a green color and streak. It is translucent, has a vitreous lustre except on the cleavage face, where it is pearly, and is soluble in acids. The crystals are too imperfect to give satisfactory measurements.

CHIOLITE AND CHODNEFFITE.—Professor P. Groth, of Strassburg, has undertaken the revision of the natural compounds of fluoric acid, the analysis being performed by Mr. Brantl, of Munich, and, as one of the first results, announces the identification of Chodneffite with Chiolite. Three analyses of perfectly pure Chiolite gave:

	I.	II.	III.
Al	17.66	(2.) 17.65	17.64
Na	25.00	24 97	25.00
F	58.00	57.30	
	100.66	99.92	

yielding the formula $5NaF+3AlF_3$.

The former analyses of Rammelsberg were made upon massive uncrystallized fragments, some of which had a composition like that given above, but from which the formula $3NaF+2AlF_3$ was deduced; other portions, however, being richer in sodium and poorer in aluminium, and for these the formula $2NaF+AlF_3$ was constructed and the name Chodneffite given.

Professor Groth now shows that these latter analyses of Ram-

[1] Zeits. f. Kryst, 1882, VI. 4, 410.

melsberg were made upon material containing cryolite as an impurity, it being impossible to separate cryolite from chiolite in the massive state. Professor Von Jeremejew has examined the crystals of chiolite and finds them to be tetragonal.

Chodneffite is merely an impure chiolite, and must be stricken from the list of minerals.

RHODIZITE.—Rhodizite, an extremely rare mineral, occurring in minute crystals upon some red tourmalines in the Ural mountains, and supposed to be a borate of lime, has been the subject of two recent communications by Bertrand to the Mineralogical Society of France. The crystals present the form of a dodecahedron, modified generally by tetrahedral faces. Bertrand concludes, from an examination of their optical properties, that the crystals are to be considered *pseudo-isometric*, and are composed of twelve elementary monoclinic crystals twinned symmetrically around a point. He has been able, moreover, actually to separate these elementary crystals by cleavage. The elementary crystal of Rhodizite consists, he holds, of an oblique monoclinic prism of 120°, of which the height is equal to the width, and of which the obliquity is 54° 44′.

CROSBY'S COMMON MINERALS AND ROCKS.—The twelfth number of the "Guides for Science Teaching," issued by the Boston Society of Natural History for the use of teachers, has been prepared by Mr. W. O. Crosby, whose contributions to the geology and lithology of Massachusetts have been of great value. It is entitled "Common Minerals and Rocks," and is an elementary sketch treated in a familiar way, admirably serving the purpose intended. About twenty-five of the rock-forming minerals are described, special stress being laid upon their acidic or basic relations and their associations. The triclinic felspars, for example, are stated to occur with basic minerals, while orthoclase is acidic in its associations. The silicates are divided into the two groups of basic and acidic; all species containing sixty per cent. or less of silica being classed as basic, while those containing more than sixty per cent. of silica are acidic. The basic silicates are *dark* colored and *heavy*, the acidic being light in color and weight, and the two classes of silicates belong to distinct rocks.

The little treatise is written from the lithologist's standpoint, and the larger portion of it treats of the origin and physical differences of rocks. The author classifies rocks according to their geological origin.

MARTITE.—O. A. Derby[1] has examined a large number of octahedral crystals of *Martite* from Brazil, and concludes that while a portion of them have resulted from the decomposition of

[1] Am. Journ. Sc. and Arts, May, 1882, 373.

pyrite, a large proportion should be considered as produced by the alteration of magnetite. Nearly half the crystals examined were attractable by the magnet, and all possible gradation between typical magnetite and hematite, both in magnetism and composition, were observed.

SMALTITE FROM COLORADO.—*Smaltite*[1] has been discovered in Gunnison Co., Colorado, in sufficient quantities to lead to the belief that it will be a commercial source for cobalt. It is associated with calcite, erythrite, and occasionally pyrite and spongy leaflets of native silver. A sample from the surface gave M. W. Iles the following result:—

Co	Fe	As	SiO_2	Pb	S	Bi	Cu	Ni	Ag	
11.59	11.99	63.82	2.60	2.05	1.55	1.13	0.16	trace	trace	= 98.89

NEW MINERAL RESINS.—*Muckite.* This is a resin found in cretaceous lignite in Moravia, and named by Schröckinger. It has the formula $C_{29}H_{28}O_2$. *Neudorfite.* This is a resin associated with the above, and probably a mixture.

THE SAND OF THE DESERT OF SAHARA.—A mineralogical study of the sand of the desert of Sahara has brought out some particulars of interest. The sand is of a yellow color. The quartz grains, which constitute ninety per cent. of the sand are remarkably rounded and not so angular as those of sea sand; a fact evidently due to attrition by the action of the wind. It is found that more than nine per cent. of the sand is composed of grains of felspar. Other minerals which exist in small proportions are chalk, clay, halite, sylvite, magnetite, chromite, garnet, olivine, amphibole and pyroxene.

MINERALOGICAL NOTES.—*Beauxite*, a substance recently shown by Fischer to be a mixture, frequently contains considerable quantities of *titanium* and *vanadium*. It has been concluded by Dieulafait that beauxite originates from the decay of primitive granitic rocks, and that if so, these rocks should contain titanium and vanadium. In a recent paper in the *Comptes Rendus*, he demonstrates that this is the case, and that these elements are widely diffused throughout the older formations.——Certain zoned crystals of *blende* possess, in addition to the six characteristic cleavages of ordinary blende, three other planes of equally ready cleavage, which have recently been studied by Hautefeuille.——*Conarite*, or more properly, *Comarite*, has been shown by Bertrand to be probably hexagonal.——M. W. Iles has detected a vanadium mineral, probably *Dechenite*, forming red and yellow incrustations at some mines in Leadville, Col. An analysis of the incrustation was as follows: SiO_2 36.86, PbO 38.51, ZnO 9.07, V_2O_5

[1] l. c., 380.

9.14, Fe_2O_3 2.59, H_2O 2.41, CO_2 .48 - 99.06.——Professor B. K. Emerson has examined microscopically the rock forming a dyke which penetrates the bed of zinc ore at Franklin, N. J., and finds that it is a micaceous diabase, composed principally of labradorite, augite, biotite, and apatite, and containing, as foreign constituents, franklinite, zincite, willemite, and calcite.——The green nickle ore from New Caledonia, exhibited in quantity at the Centennial Exhibition, and known by the name of *Noumeite* or *Garnierite*, is an amorphous hydrous silicate of magnesia, containing more or less admixture of oxide of nickle. It has been considered as allied to Genthite, though probably a mixture. Bertrand considers that its optical character is that of a uniaxial substance.——Professor Shepard withdraws the species *Glaubapatite*, a name which he had given to a supposed soda-bearing guano. The soda was due to the damaged state of the cargo of the vessel in which the guano was shipped.

GEOGRAPHY AND TRAVELS.[1]

THE CONGO.—The treaty made by M. Savorgnan de Brazza with the native chiefs at Stanley Pool, is published in the *Proceedings* of the Royal Geographical Society for April. It is dated October 3, 1880, and cedes the territory between the rivers Jué and Impila to France for the establishment of a station. Mr. Stanley on arriving at Stanley Pool was not allowed to establish a depot or proceed any further in consequence of this agreement, which is considered by the native chief Makoko, as binding him not to receive any Europeans but Frenchmen.

Mr. Stanley on his way up the Congo to the Pool, passed from Isangila to Manyanga entirely by river, but after that, he was obliged to make a road seven miles long, past the Ntombo Mataka Falls where he was again able to take to the river.

The French missionary Père Augouard has also visited Stanley Pool, and on his way discovered a river over eighty feet broad, named the Eluala, which is not marked on Stanley's map.

The natives have also ceded a tract of land on the Congo at Manyanga, to the Belgian expedition for a depot.

Just below the boundary of this tract, the Baptist mission has chosen a site and are building a house. On each side of the river there are many native towns within a short distance of this spot.

LAKE NYASSA.—The headquarters of the missionaries on this lake, has been removed from Livingstonia at Cape Maclear to Bandawé at Misangi Point, S. lat. 11° 56′ E. long. 34° 6′, a more healthy and central port. The new road from Nyassa to Tanganyika is to be begun soon. A new steamer is to be sent out by the London Missionary Society to Quillimane and thence to the north end of Nyassa and over the new road when finished, to

[1] Edited by ELLIS H. YARNALL, Philadelphia.

Lake Tanganyika. The water however, continues to fall in the Nyassa, and also in the river Shire, and the navigation of the latter is increasingly difficult. The careful observations on the changes in the water-level made during the past four or five years, will prove of much practical as well as scientific importance.

O'NEILL'S JOURNEY IN MAKUA LAND.—In the NATURALIST for April last, we gave a short account of recent journeys in the Makua country lying west from Mozambique. An interesting paper by one of these travelers, Mr. O'Neill, British Consul at Mozambique, was read at a recent meeting of the Royal Geographical Society.[1] As was stated by Lord Aberdare, the President of the Society, "a remarkable fact in connection with the subject, is that the vast territory of Mozambique for the last 200 years had been in the possession of the Portuguese, and yet, so far as could be ascertained, no Portuguese of unmixed blood had ever been more than twenty miles inland."

One of the most interesting features of this journey, is the intelligence thus obtained of the existence of a lofty snow-clad peak in this part of the African continent. It is doubtless the same mountain Mr. Maples heard of when at Meto. Mr. O'Neill writes:—"Whilst at Namùrola, I also ascended a hill 500 or 600 feet high, and had a fair view of the mountain range which rises up west of the valley of the Malema, culminating in the Inagu Hills and Namuli Peak, and forming, if native accounts be correct, the water-shed of the rivers of the Mozambique coast, and those that on its western side help to feed the Lake Kilwa[2] and its outlet, the Lujende or Liendi. I wish, however, distinctly to say, that although the position of Namuli Peak was pointed out to me, I could not clearly distinguish it. A magnificent range of hills was visible, running apparently north-east and south-west, but the summits of its peaks and many of the hills themselves were totally lost in the mass of cloud and mist which the southerly winds had been drifting up during the past week, and which were, even now, descending as the first of the rains. I have concluded that this peak is snow-clad from the repeated accounts I have received, not only from coast men who have traded in the Malema valley, but also from chiefs and others who live comparatively near the spot. The usual description of it is, "Its top is always white,' and 'Mnwisho zake huwezi kuma,' or 'Its summit is invisible.'"

In an address made by Mr. Joseph Thomson after the reading of this paper, he said, "It was a very interesting and suggestive fact, that three Englishmen should have been traveling in the same country at the same time without any knowledge of each other's movements, and yet, not infringing on each other's districts.

[1] Royal Geographical Society *Proceedings*, April, 1882.

[2] Lake Kilwa is probably identical with the Lake Shirwa of Livingstone and Kirk. [ED.

Thus, Mr. O'Neill kept to the south of the Upper Makua country, the Rev. Chauncy Maples to the middle part, and he (Mr. Thomson) along the northern boundary up the river Rovuma and the Lujende. From the reports of those travelers, together with the accounts given by Bishop Steere and Von der Decken further north, it was very evident that the same natural features extended from the Rufigi to the Zambesi, viz: a slightly undulating and irregular country, at one time spreading out in a great plain, at another forming a narrow valley; while small ridges of hills and isolated picturesque peaks diversified the scenery.

Geologically, the country consisted of metamorphic schists, gneiss, and granite. The schists had been worn away and washed down, forming the plains in the valleys; while the bosses of hard, compact rock had remained as the ridges of hills and isolated peaks. Of course, the most interesting part of Mr. O'Neill's journey, was the neighborhood of the mountain range in Makua, and the strange peak Namuli. That range evidently marked the commencement of the central plateau; and as to the peak Namuli, there could be little doubt that it was snow-clad, because Mr. Maples obtained his information about it from sources quite independent of Mr. O'Neill, and the reports of the two travelers were exactly identical. Considering its position, it must be over 16,000 feet high to be snow-clad. He had no doubt that it would prove to be volcanic; and if so, it would form another link in the chain from the Red Sea to the Cape, which had given rise to the volcanic deposits in Abyssina at Kilimanjaro, and the enormous series of tufas and lavas which he (Mr. Thomson) discovered round the north end of Nyassa. That line of volcanoes coincided with the line of weakness and dislocation, along which the eastern side of the continent had been upheaved. The areas of depression, Nyassa and Tanganyika, were also approximately parallel to the line of dislocation."

Mr. O'Neill also mentioned an error in the map, by Dr. Petermann[1] in which two lakes appear situated on a tributary of the Lurio, one of which is placed in the heart of Makuani. "I made careful and constant inquiries with respect to these lakes, and was every where assured that no such existed in the Makua country or upon any tributary of the Lurio. The only lake that I can hear of, is that of Kilwa, in the Ajawa country, which, as I have before said, is reported to be the scource of the Liendi. It seems not improbable, that there has been some confusion between these lakes. This probability is strengthened by the native statement that the Lake Kilwa is situated in a district called Muongoje, which name I find upon the shore of the easternmost lake in Petermann's map."

ABYSSINIA.—M. Raffray, French Vice-Consul at Massowah, in a recent journey to the camp of the King of Abyssinia, passed

[1] See Map No. 71. Sud Afrika und Madagaskar Stieler's Atlas.

through a portion of that country which is very little known and very different in character from other parts of it—the inner basin of Lake Aussa. The region is thickly wooded, and trees unknown elsewhere are found there. He visited Lake Ashangi (8254 feet) which has no apparent outlet. The level of the lake remains the same throughout the year, and its waters run off through subterranean channels. After traversing the plains inhabited by the Raya Gallas, he ascended the Zebul mountains, an isolated chain, from which the whole Ethiopian mountain system could be seen to the westward, for over seventy miles, while to the eastward immense plains stretched down to the shores of the Red Sea and enclosed the great depression of Lake Aussa—the basin which receives the waters of the Abyssinian plateaux. He afterwards ascended the lofty plateaux of Monts Abboi-Miéda and Abuna-Yusef, the passes of which are respectively 11,400 and 13,200 feet above the sea-level. M. Raffray describes these lofty summits on which grows a plant, reaching a height of twenty-six feet, the *Rhynchopetalum montanum*, and on which are found insects similar to those of temperate Europe. In speaking of the zoölogy of Abyssinia, and especially of the lower classes of animals found there, he defines four distinct regions of different altitudes. The first or coast region belongs to the fauna of the Sahara; the second or valley region, has a fauna similar to that of the Senegal; the region of the lofty plateaux is more peculiarly Abyssinian, with a strikingly similar fauna to that of the Mediterranean; and lastly, the region of mountain tops, varying in altitude from 11,483 feet to 13,124, belongs to the fauna of the mountainous parts of temperate Europe.

Schuver.—Mr. Schuver is continuing his explorations in the region south-west of Abyssinia. He finds that there are two Jaboos rivers—the word meaning simply a running stream. The Jaboos of the Blue Nile has its most southern and principal source at the foot of the lofty Mount Wallel, in lat. 8° 50′ N. The most easterly and chief sources of the River Yal (affluent of the White Nile) is in the western valleys of the Shugru Mountains, the eastern base of which is bathed by the Blue Nile Jaboos. As far as the Yal flows through the territory of the Aman negroes, it bears the name of Valasat, but after it has passed the Banghe defile in a series of cataracts falling 2000 feet in twelve miles, and reaches the Berta country, it takes the name of Jaboos, the name by which the other permanent river of that country is known. In ascertaining these interesting facts, Mr. Schuver followed the western Jaboos down to the junction of the Owé, the principal river of the valleys south of Gomashe; thenceforward it passes into the Burus plains, where it takes its final name of the Yal.

THE NEW POLAR STATIONS.—The Danish station has been changed from Upernavik, as first proposed, to a more southerly position at Godshaab, on the west coast of Greenland, so as to be at a greater distance from the American station at Lady Franklin Bay and the Austrian at Jan Mayen. The expedition, which is well fitted out at government expense, will sail from Copenhagen about May 20th, and is expected to reach Godshaab at the end of June. It is to remain there until September, 1883.

The Dutch propose to establish their station at Dicksonshavn, at the mouth of the river Yenisei, unless the ice prevents their reaching it, in which case they will go to the north-east point of Novaya Zemlya. Funds have been supplied for this purpose partly by the government and partly by public subscriptions. The party will be about twelve in number and will take with them all the instruments and apparatus specified by the International Polar Conference besides other instruments and a wooden house. It is hoped that an ascent of the Yenisei can be made in a steam launch.

The British Government has granted the sum of £2500 and the Canadian Government $4000 for a circumpolar station.

The Italian Antarctic Expedition started from Buenos Ayres on November 8, 1881, under command of Lieutenant Bove. The government of the Argentine Republic has sent out a commission with the expedition for the purpose of carefully revising the survey of the coast of their country; thus the expedition now consists of four ships, viz: *Santa Cruz*, *Uruguay*, *Cape Horn* and a steam bark. The *Cape Horn* is the largest vessel and will proceed to the Antarctic regions, while the *Uruguay* will remain at Cape Horn. Lieutenant Bove hoped to leave Cape Horn by the end of December, in order to sail across to South Shetland and Grahamsland. He hoped to be back at Tierra del Fuego by the end of March, to stay there until May, and then to leave for Buenos Ayres.

MICROSCOPY.[1]

MEASUREMENT OF MICROSCOPIC APERTURE.—Hon. J. D. Cox, in a very interesting article in the *Am. Month. Mic. Journ.*, discusses the present method of measuring angular aperture of the microscope by taking the angle of which the apex is the center of the microscopic field of view, and whose sides bound the telescopic field of view when the microscope is turned into a telescope, either by removing the ocular and looking down the tube with the naked eye, or by substituting a terrestrial eye-piece by restoring the ocular and adding an objective as an erector in the draw-tube. By experiments, confirmed and explained by geometric principles, he concludes that the telescopic aperture, however correctly measured, is not the microscopic aperture; and that the difference, which is practically immaterial in objec-

[1] This department is edited by Dr. R. H. WARD, Troy, N. Y.

tives of high power and short working distance, may become, with low powers, large enough to destroy the usefulness of the common methods of measurement of the lenses measured, a ¾-inch varied from 36° to 38° telescopic aperture to 39½° microscopic, while a 3-inch ranged from 13½° to 19°. Change of draw-tube caused a variation of several degrees.

A NEW JOURNAL.—The (English) Postal Microscopical Society has undertaken the publication of a quarterly journal, the first number of which appeared in March. It is edited by the very able Hon. Sec'y of the Society, Mr. A. Allen, of Bath, and published by W. P. Collins, of London. Its primary object is the preservation of the most important notes and drawings from the note-books of the Society; but it will also contain original papers, notes, extracts, and correspondence upon microscopical subjects. It will be freely illustrated, and will doubtless prove an entertaining and instructive visitor.

SUMMER SCHOOL OF BIOLOGY.—Microscopists can enjoy rare opportunities for sea-shore collecting and laboratory work, at the Summer School of Biology of the Peabody Academy of Science, which opens at Salem, Mass., on July 11, and continues four weeks. Among the special advantages for microscopical students, will be a course of lectures on physiological botany, by Professor C. E Bessey, of Iowa, and a course on anatomy and physiology of vertebrates, by Professor A. H. Tuttle, of Ohio.

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SCIENTIFIC NEWS.

— It appears that the hunting of alligators in Florida is carried on to such an extent as to threaten the extirpation of the species there. Nothing is used except the skins on the belly and legs. The rough scaly plates on the back are rejected. The heads are cut off and buried for a few days, till the tusks can be detached. It was announced lately that one person had collected alligators' teeth to the amount of three hundred and fifty pounds. This will give some idea of the destruction going on. On the St. John's river a new method of hunting has been devised. A dark lantern, with a powerful reflector, is used on suitable nights; and no difficulty is experienced in approaching the quarry. The animals seem bewildered with the strong glare, and make no effort to escape. The gun is held within a few feet of the head—a touch to the trigger, and there is one "gator" less in Florida. This process is very effective, and the hunters are enabled, not only to kill, but to secure their prey. Large numbers of these animals are slain annually by tourists for amusement only, besides those slaughtered for profit. Further, many young alligators are stuffed as specimens, or sent off alive as curiosities, while myriads of eggs are blown or disposed of by dealers.—*English Mechanic.*

— The views of Dr. Hahn, as to the presence of organic structures in meteorites, have been refuted by Professor Carl Vogt, who, in a memoir presented to the French Academy of Sciences, affirms that Dr. Hahn has no foundation for his conclusions, and that in no single case do the pretended organic structures present the microscopic appearance of the organisms for which they have been mistaken.—*English Mechanic.*

— G. T. Wetterman, Director of the Museum Koninklijk Zoölogisch Genootschap, Amsterdam, Holland, writes that within a short time the new aquarium buildings, recently erected in the gardens, will be opened, not only for the recreation of the members of the society but to audiences for the academical course of zoölogy, as well as for laboratories for anatomical research. Director Wetterman states that naturally all sorts of sea animals will be needed for the work, and requests the addresses of aquaria in America that will enter into a mutual exchange of marine animals or will dispose of them by sale. He expresses a wish to have as much as possible of the American submarine fauna represented in their tanks.

— James Geikie, LL. D., author of the "Great Ice Age," and for twenty-one years a member of the Geological Survey of Great Britain and Ireland, has recently received the appointment to the Murchison Professorship of Mineralogy and Geology in the University of Edinburgh, made vacant by the appointment of his brother, Professor Archibald Geikie, to the director-generalship of the Geological Survey. He has resigned his position in the survey and enters upon his duties in the University in May.

— But two summer schools of science will apparently be opened to students this coming season, one at Annisquam, Cape Ann, Mass., under the charge of Professor A. Hyatt, curator of the Boston Society of Natural History; the other is the summer school of biology of the Peabody Academy of Science, Salem, Mass. Both offer good facilities for study.

— We are asked by Professor E. S. Morse to correct a mistake on page 326 of the NATURALIST in reference to the Japanese students. Mr. Ijima and Mr. Iwakawa have never been abroad, what they have acquired has been learned in Japan. Mr. Mitsukwri was a fellow at Johns Hopkins University and was a student of Professor W. K. Brooks.

— The Princeton College Exploring Expedition obtained a skull of the Eocene mammal *Achænodon insolens* Cope, whose position has been heretofore doubtful. It turns out to be a flesh-eater of the family *Arctocyonidæ*, and is the largest species known. It was a formidable animal, as large as a brown bear, and is probably the ancestral type from which bears were derived. Messrs. Scott and Osborne will publish a memoir on it in the Contributions of the Museum of Geology and Archæology.—*E. D. Cope.*

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

NATIONAL ACADEMY OF SCIENCES.—The Academy met in the National Museum, Washington, on Tuesday, April 18, 1882, President W. B. Rogers in the chair. The papers of the first day were:

1. The course of the Gulf stream since the Cretaceous period, Alexander Agassiz. 2. The Pre-cambrian rocks of Italy, T. Sterry Hunt. 3. Notes on the geology of Yucatan, Alexander Agassiz. 4. Desiccation of the Plateau of Mexico, Alexander Agassiz. 5. On the brain of Phenacodus, E. D. Cope. 6. On the young stages of a few osseous fishes, Alexander Agassiz. 7. The affinities of Palæocampa Meek and Worthen, as evidence of the wide diversity of type in the earliest known Myriapods, S. H. Scudder. 8. On the genesis and development of the Chiropterygium from the Ichthyopterygium, Theodore Gill.

Wednesday, April 19, 1882.—9. Preliminary notice of a new Dividing Engine, H. A. Rowland. 10. On photographs of the spectrum of the nebula in Orion, Henry Draper. 11. Theory of concave gratings, H. A. Rowland. 12. On the influence of time on the change in the resistance of the carbon disk of Edison's Tasimeter, T. C. Mendenhall, presented by G. F. Barker. 13. Note on a special form of secondary battery or electric accumulator, Wolcott Gibbs. 14. Researches on complex inorganic acids (continued), Wolcott Gibbs. 15. Biographical notice of Professor John W. Draper, G. F. Barker. 16. Some discoveries that enhance the value of the cotton and orange crops, C. V. Riley.

Thursday, April 20, 1882.—17. The relation of rain-areas to areas of low pressure, Elias Loomis. 18. Description of an Articulate of doubtful relationship from the Tertiary beds of Florissant, Colorado, S. H. Scudder. 19. Mythology of the Zuñi Indians, F. H. Cushing. 20. On the polarization of the light of the Moon, A. W. Wright. 21. On the results of the incandescent lamp tests at the Paris Exhibition, G. F. Barker. 22. On the infra-red portion of the solar spectrum as studied with the bolometer, S. P. Langley.

Friday, April 21, 1882.—23. On the formation of metalliferous vein formation at Sulphur Bank, California, Joseph Leconte. 24. On a form of standard Barometer, A. W. Wright. 25. On a marsupial genus from the Eocene, E. D. Cope. 26. On a fallacy in induction, C. S. Peirce. The committee to examine into the investigations into the value of sorghum as a source of sugar, made an interesting report. Professor Ira Remsen, of Baltimore, was elected a member.

PHILADELPHIA ACADEMY NATURAL SCIENCES, Dec. 13.—Mr. Ryder described the development of fish eggs. He agreed with His and Rauber in the opinion that the rim of the blastoderm goes to form a part of the muscular plates of the side of the body.

Dec. 20.—Mr. Martindale read a history of the connection of Dr. Ruschenberger with the academy, as testimony to his services, on the occasion of his declining re-nomination to the presidency.

Dec. 27.—As the result of the annual election it was announced that Dr. Jos. Leidy was duly elected president of the Academy.

Jan. 3, 1882.—Mr. Ryder confirmed, by the result of his observations on additional types, the formation of vacuoles in the notochord of teleost fishes; and stated that although the tissue of the neural and enteric portions of the neurenteric canal were continuous, no open canal connected those portions. Dr. Leidy called attention to the composition of the gravels of Philadelphia and its vicinity, The commonest pebbles are quartz or quartzite, while those next in frequency are red-sandstone, probably mesozoic. Conglomerates are also found, but fossiliferous pebbles are very rare.

Jan. 10.—Mr. Heilprin called attention to the tidal theory of Professor Ball, and stated that the existence of life upon the coast tended to nullify some of Professor Ball's conclusions.

Mr. Potts described a new sponge, *Heteromeyenia ryderi*, also a new species of *Tubella*, which he named *T. pennsylvanica*. The seed-bodies of this latter sponge range from $\frac{1}{60}$ to $\frac{1}{75}$ of an inch in diameter. He showed how the statoblasts of sponges like *Spongilla fragilis* and *Carterella* form layers upon rocks, etc., after the spicules of the sponge have been washed away. The subject of the algous parasitic chlorophyll cells in certain sponges, infusoria, and mollusks was discussed by the president and Mr. Ryder.

Mr. Meehan related an incident which indicated that sparrow-hawks can see mice when perched at a horizontal distance of 500 feet.

Jan. 17.—Papers upon the new Crinoids of the Chemung period from the State of New York, by H. S. Williams, M. D.; the Species of Odontomya found in the United States, by Dr. L. T. Day, and a new station for *Corema Conradii*, by Aubrey H. Smith, were presented for publication. Mr. Redfield spoke of the extreme rarity of *C. Conradii*.

MIDDLESEX INSTITUTE. Feb. 28.—L. L. Dame, president, delivered an instructive lecture, the first in a series of twelve weekly botanical lectures, on the "Growth of the plant from the seed," to a class of nearly fifty members.

March 7.—Mrs. A. J. Dolbear gave the second in the series, her subject being, "Morphology of roots, stems, and branches."

March 8.—President Dame briefly reviewed the first year's work of the Institute, and made some excellent suggestions in regard to the best manner of carrying on the work which the Institute had undertaken.